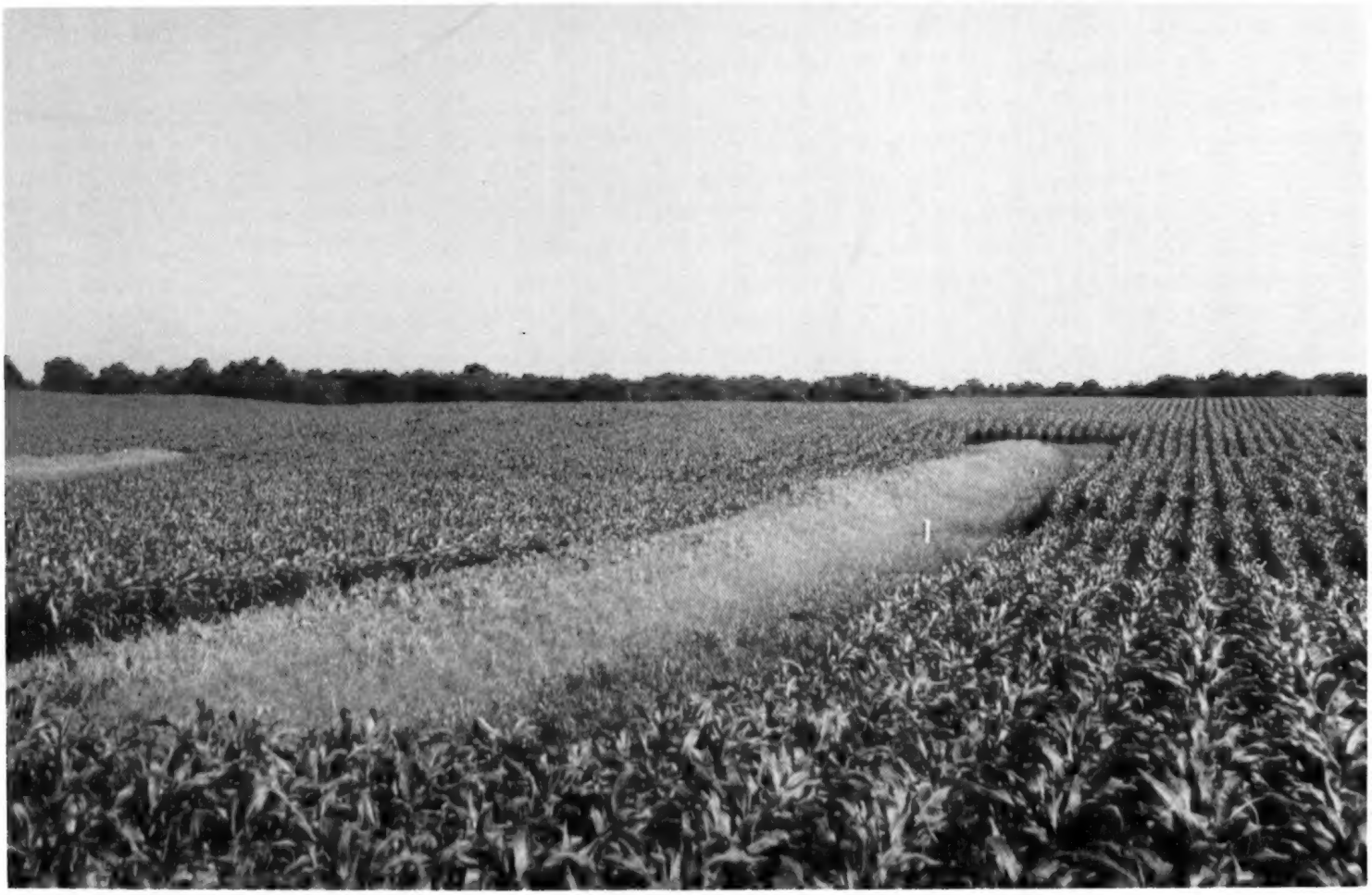
United States Department of Agriculture

Soil Conservation Service

In cooperation with Iowa Agriculture and Home Economics Experiment Station; Cooperative Extension Service, Iowa State University; and Department of Soil Conservation, State of Iowa

Soil Survey of Hamilton County, Iowa



HOW TO USE

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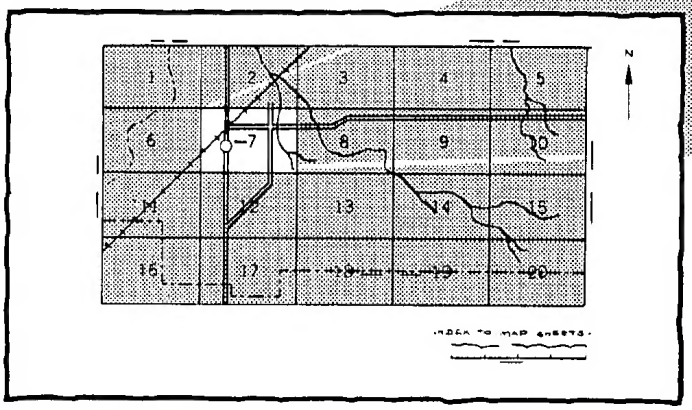

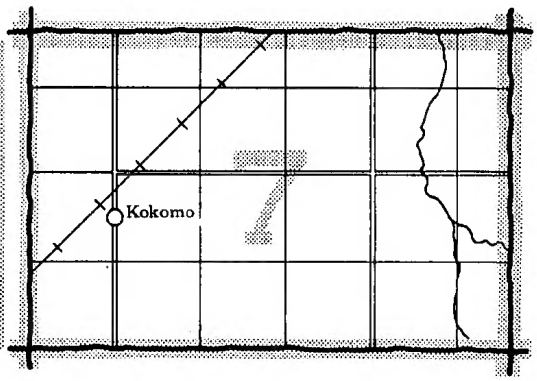

2. Note the number of the map sheet and turn to that sheet.

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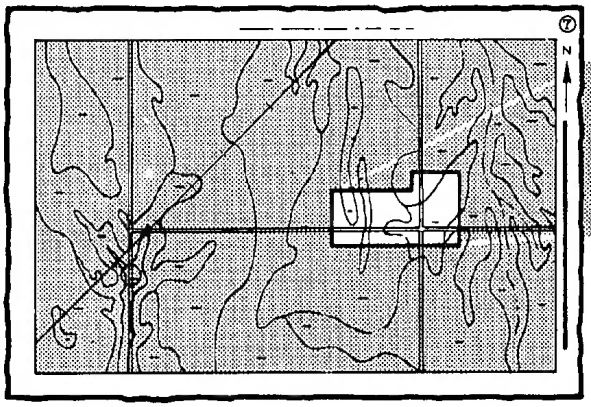
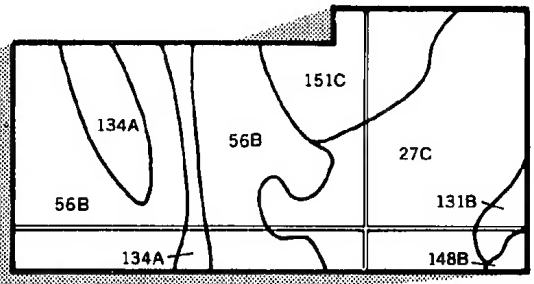
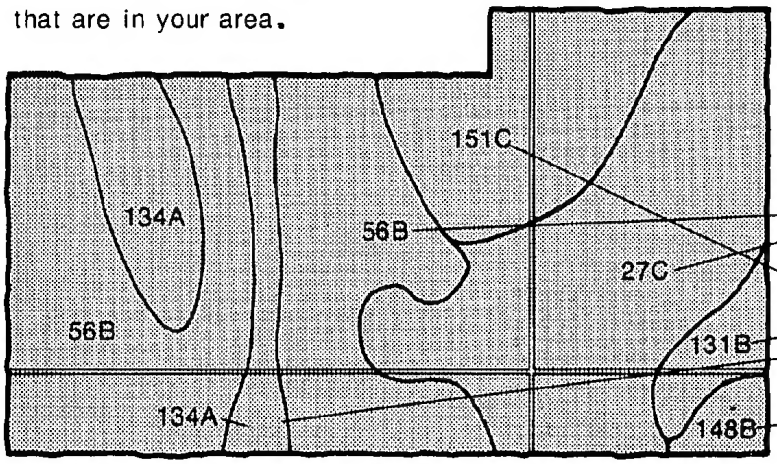




4. List the map unit symbols that are in your area.

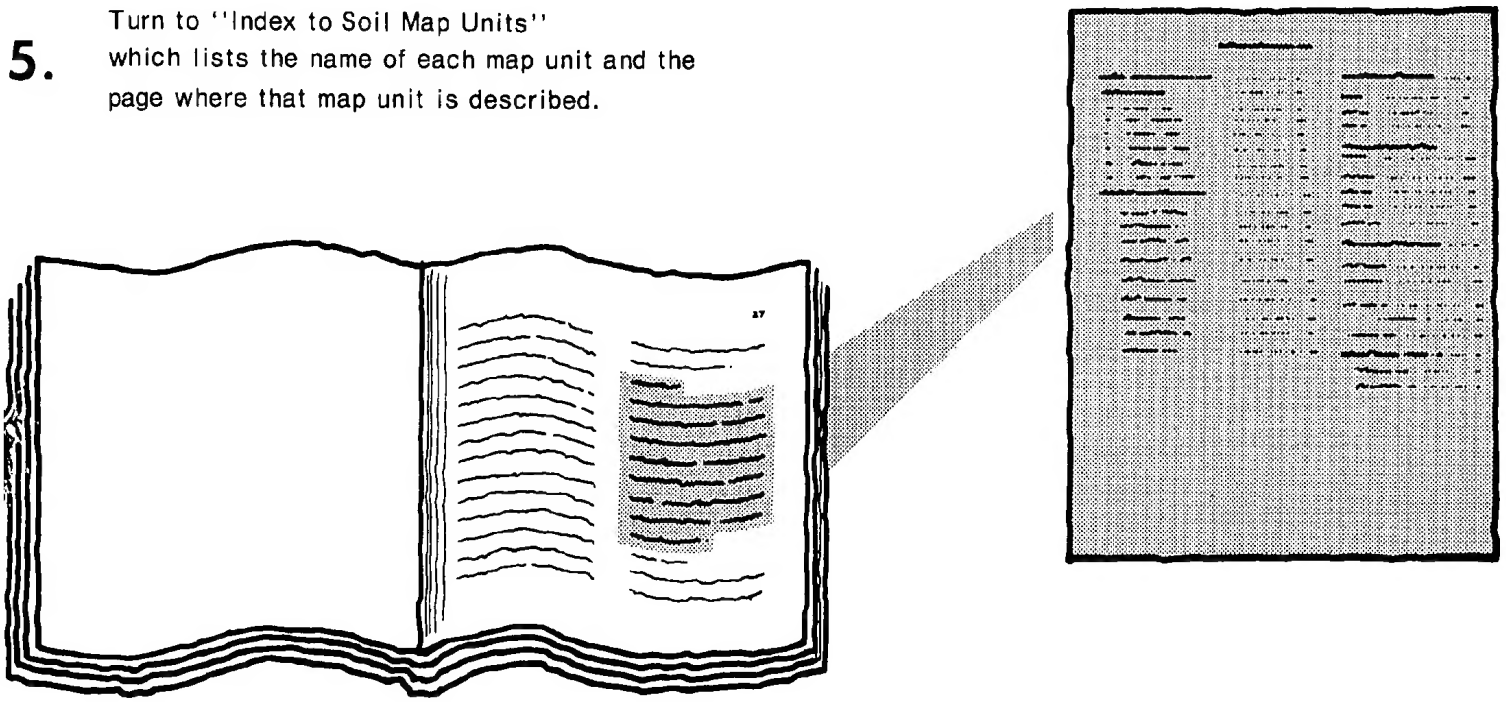


Symbols

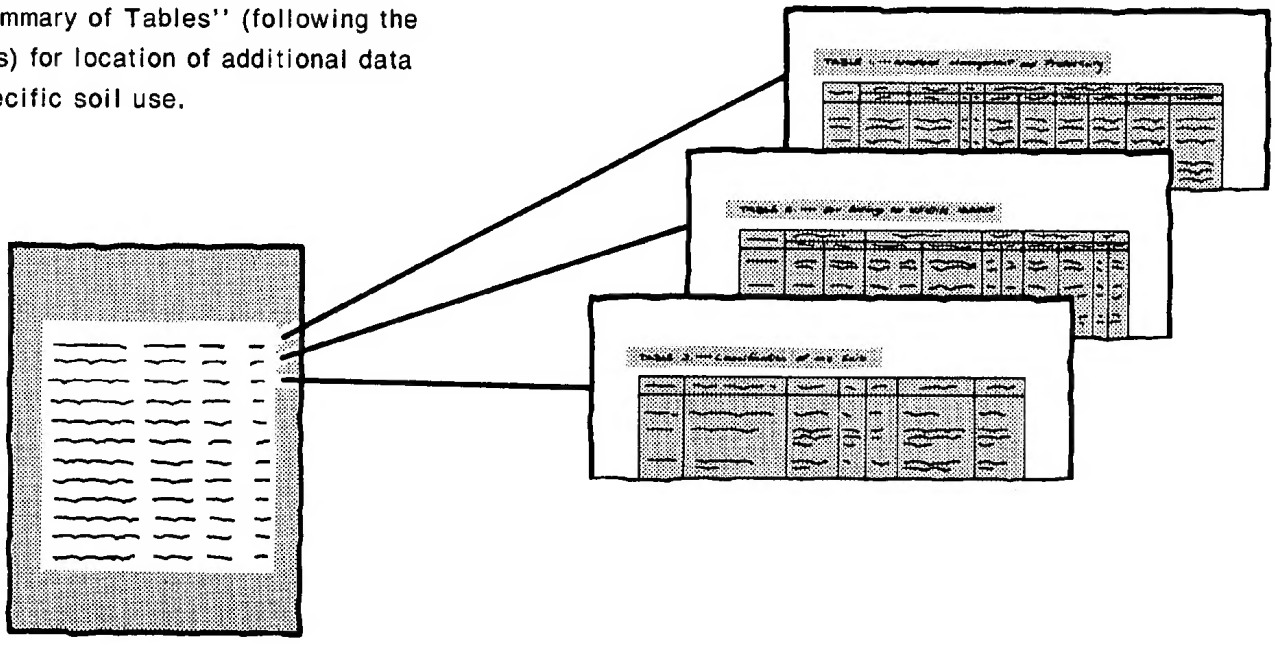
- 27C
- 56B
- 131B
- 134A
- 148B
- 151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1977-83. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Hamilton County Soil Conservation District. Funds appropriated by Hamilton County were used to defray part of the cost of the survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Water and sediment control structures on Clarion loam, 5 to 9 percent slopes. These structures help to control erosion.

Contents

Soil Series

Issued July 1986

Index to Map Units

Summary of Tables

Preface

This soil survey contains information that can be used in land-planning programs in Hamilton County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Soil Survey of Hamilton County, Iowa

By Robert O. Dideriksen, Soil Conservation Service

Fieldwork by Robert O. Dideriksen, Elmer H. Harvey, Byron F. Chalstrom, Maynard P. Koppen, and Paul V. Sadler, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Iowa Agriculture and Home Economics Experiment Station;
the Cooperative Extension Service, Iowa State University;
and the Department of Soil Conservation, State of Iowa

HAMILTON COUNTY is in the north-central part of Iowa (fig. 1). It has a total area of 369,563 acres, or 577 square miles. Webster City is the county seat. It is about 20 miles east of Ft. Dodge and 70 miles north of Des Moines.

Farming is the main enterprise in Hamilton County. Industrial activity, however, including the manufacturing of household appliances, is increasing in Webster City.

This survey updates the soil survey of Hamilton County published in 1920 (*3*). It provides additional information and maps that show the soils in greater detail.

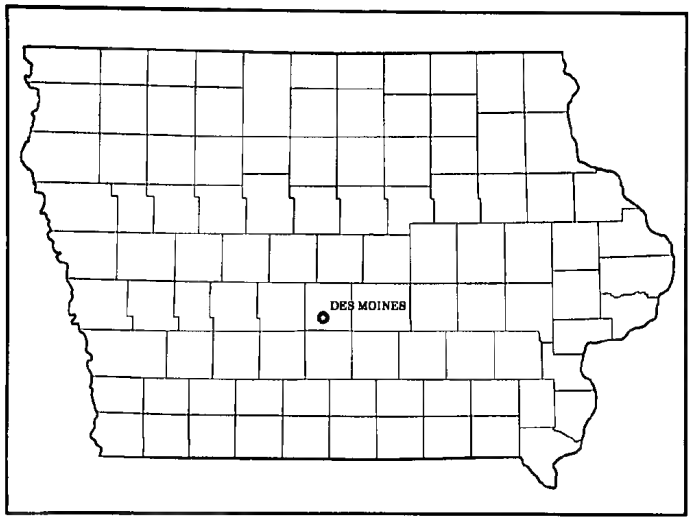


Figure 1. Location of Hamilton County in Iowa.

General Nature of the County

This section provides general information about the climate, relief and drainage, history and development, and farming in Hamilton County.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Webster City, Iowa, in the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 20 degrees F, and the average daily minimum temperature is 11 degrees. The lowest temperature on record, which occurred at Webster City on February 9, 1972, is -31 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which

occurred at Webster City on July 30, 1955, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 29.69 inches. Of this, 22 inches, or about 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 6.27 inches at Webster City on July 7, 1955. Thunderstorms occur on about 50 days each year, and most occur in summer. Tornadoes and severe thunderstorms strike occasionally. These storms are local in extent and of short duration and result in sparse damage in narrow belts. Hailstorms occur at times during the warmer part of the year in irregular patterns and in relatively small areas.

The average seasonal snowfall is 30 inches. The greatest snow depth at any one time during the period of record was 23 inches. On the average, 40 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

Relief and Drainage

Most of the soils in Hamilton County are nearly level to gently rolling and are on glacial drift plains. In areas near the Boone River, however, the soils are rolling to very steep. The prevailing slope of the county is to the south. Large areas between drainage systems are nearly level and have only slight undulations. The relief is more pronounced in marginal areas near the flood plains along the larger streams.

The difference in elevation between the lowlands and the adjoining uplands generally is 50 to 100 feet. The highest elevation, 1,262 feet above sea level, is about 6 miles north of Blairsburg, near the Wright County line (*7*). The lowest point, 930 feet above sea level, is in an area where the Boone River crosses the western boundary into Webster County and where it joins the Des Moines River.

Hamilton County is in the upper Mississippi River drainage basin. The rivers, streams, and water in drainage ditches generally flow in a southerly direction. All of the county is drained by tributaries of the Des Moines, Boone, Skunk, and Iowa Rivers, which are tributaries of the Mississippi River (*8*). Some areas along the Boone River and along tributaries of the Skunk River are good sources of sand and gravel.

There are two lakes in Hamilton County Wall Lake and Goose Lake. Several marshy areas have been artificially drained and are now farmed. In general, artificial drainage is extensive. Tile and drainage ditches carry away the surface water from the level uplands.

History and Development

The first settlement in Hamilton County was established at the junction of the Boone and Des Moines Rivers in 1849. The early settlers favored the wooded areas along these two major rivers. In these areas, game was plentiful and the forest provided fuel and protection from severe storms in winter. In 1850, two families moved into an area on the banks of the Boone River. They named the area Newcastle. Newcastle was renamed Webster City in 1856 and later became the county seat (*10*).

The population and the number of farms gradually increased in the early 1850's. The settlers farmed the better drained areas first. Much of the territory was poorly drained. Most farms were small. The principal crops were corn, oats, and wheat, which were grown for home use. A few horses, cattle, and hogs generally were kept on the farm.

Hamilton County was organized in 1857. As more settlers arrived, some mills were built along the Boone River. They were operated by water power. After the building of railroads, which provided improved marketing facilities and increased the demand for and value of agricultural land, drainage systems were planned and installed.

The population of the county was 122 in 1852. All of the residents were classed as rural. The population was 20,978 in 1930, 18,383 in 1970, and 17,834 in 1980 (*14*). Webster City has a population of about 9,000 (*6*). Other towns and villages in the county include Blairsburg, Ellsworth, Flugstad, Highview, Homer, Jewell, Kamrar, Randall, Stanhope, Stratford, and Williams.

Farming

Hamilton County is chiefly agricultural. If properly managed, the soils have good potential for crops. The principal crops are corn and soybeans. Oats and hay are grown on small acreages. In some small areas wheat, grain sorghum, sunflowers, sweet corn, and grasses are occasionally grown. Corn and soybeans are the most important cash crops. Some of the corn and most of the hay and oats are fed to livestock. Beef cattle, hogs, and a small number of sheep are raised on some farms. Because of an increased emphasis on the production of

grain as a cash crop, the number of cattle fed decreased from 27,000 in 1977 to 25,000 in 1979. The number of hogs fed increased from 245,000 to 255,000 during the same period (*4*). The crops and the livestock are the principal sources of income in the county.

The number of farms decreased from 1,394 in 1972 to 1,200 in 1983 (*5, 6*). The average size of the farms increased from 258 to 290 acres during the same period. The total acreage of farmland decreased from 359,856 acres in 1972 to about 340,000 acres in 1983.

With the development of agriculture, farmers began to recognize the need for good soil management. In 1946, the Hamilton County Soil Conservation District was organized. Many farmers are now active in applying soil conservation practices.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic

classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Brownton-Ottosen-Bode Association

Nearly level to moderately sloping, poorly drained, somewhat poorly drained, and well drained, silty and loamy soils formed in glacial or lacustrine sediments and in the underlying glacial till; on uplands

This association consists of soils on broad upland flats and short, convex or plane side slopes. There are many scattered potholes, and the natural drainage pattern is poorly defined. Most of the association is drained by tile and surface outlets. Large drainage ditches have been dug to provide outlets for tile drains. Slopes range from 0 to 9 percent.

This association makes up about 32 percent of the county. It is about 30 percent Brownton soils, 25 percent Ottosen soils, 20 percent Bode soils, and 25 percent minor soils (fig. 2).

Brownton soils are poorly drained, are nearly level, and are on flats and in swales. Ottosen soils are somewhat poorly drained, are very gently sloping, and are on convex side slopes. Bode soils are well drained, are gently sloping and moderately sloping, and are on side slopes.

Typically, the surface layer of the Brownton soils is black, calcareous silty clay loam about 9 inches thick. The subsurface layer is black and very dark gray, calcareous silty clay about 13 inches thick. The subsoil is dark gray and olive gray, mottled, firm silty clay about 16 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous clay loam.

Typically, the surface layer of the Ottosen soils is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 6 inches thick. The subsoil is dark grayish brown, mottled, friable clay loam about 17 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam and clay loam.

Typically, the surface layer of the Bode soils is black clay loam about 8 inches thick. The subsurface layer is very dark brown and dark brown clay loam about 10 inches thick. The subsoil is friable clay loam about 24 inches thick. The upper part is brown, and the lower part is grayish brown and mottled. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous loam.

Kossuth, Harps, and Okoboji are the minor soils in this association. The poorly drained Kossuth and Harps soils have a silty or loamy subsoil. Kossuth soils are on upland flats and in narrow drainageways, and Harps soils are around depressions. The very poorly drained Okoboji soils are in the depressions.

Corn and soybeans are the principal crops grown on these intensively cultivated soils. Cash grain farming is the dominant type of farming. The few areas of pasture and hay are small fields adjoining small streams. Some marshes have not been been drained and are used for wildlife habitat.

The major soils in this association are well suited to all of the crops commonly grown in the county. The main concerns of management are improvement of drainage in the wetter soils and control of erosion on the more sloping soils. On much of this association, artificial drainage is needed. Most areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions. Wind erosion is a hazard. If large areas are left bare after the soils are plowed in the fall, ditches can become filled with snow or soil.

2. Clarion-Canisteo-Storden Association

Nearly level to moderately steep, well drained and poorly drained, loamy and silty soils formed in glacial sediments and glacial till; on uplands

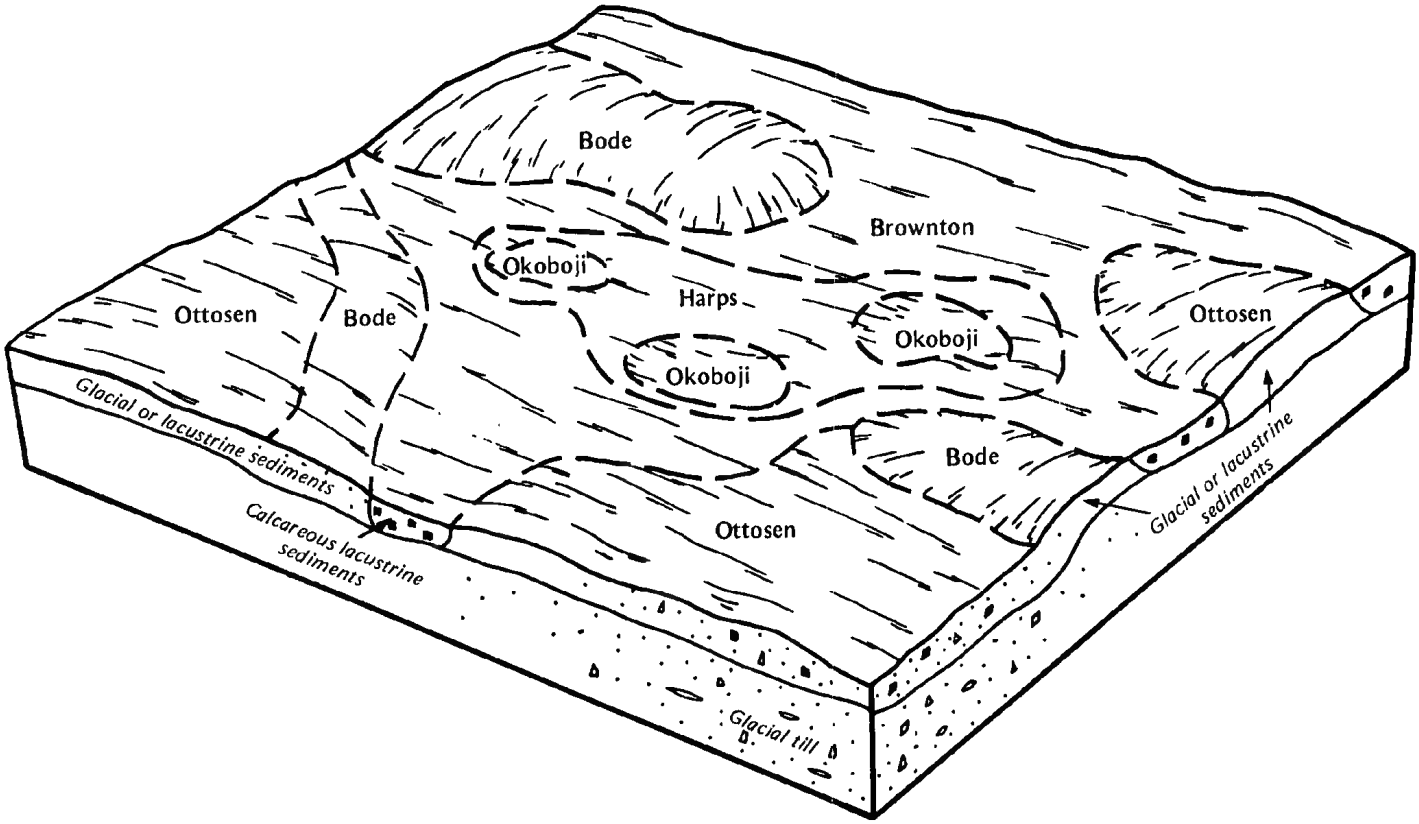


Figure 2. Typical pattern of soils and parent material in the Brownton-Ottosen-Bode association.

This association consists of soils on flats, knolls, and side slopes. Many scattered potholes are in the nearly level areas. These areas are drained by tile and surface outlets. Slopes range from 0 to 18 percent.

This association makes up about 18 percent of the county. It is about 40 percent Clarion soils, 25 percent Canisteo soils, 10 percent Storden soils, and 25 percent minor soils (fig. 3).

Clarion soils are well drained, are gently sloping and moderately sloping, and are on knolls and side slopes. Canisteo soils are poorly drained, are nearly level, and are on flats and swells. Storden soils are well drained, are moderately sloping to moderately steep, and are on knolls and side slopes.

Typically, the surface layer of the Clarion soils is black loam about 7 inches thick. The subsurface layer is very dark brown and dark brown loam about 11 inches thick. The subsoil is about 18 inches thick. It is dark yellowish brown, friable loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Canisteo soils is black, calcareous silty clay loam about 7 inches thick. The subsurface layer is black and very dark gray, calcareous clay loam about 13 inches thick. The subsoil is friable, calcareous clay loam about 24 inches thick. The upper part is grayish brown, and the lower part is light olive gray and mottled. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Storden soils is dark grayish brown, calcareous loam about 6 inches thick. Plowing has mixed some streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown, mottled, and calcareous in the lower part.

Webster, Harps, Okoboji, Nicollet, and Zenor are the minor soils in this association. The poorly drained, noncalcareous Webster soils are in narrow drainageways. The poorly drained, highly calcareous Harps soils are around depressions. The very poorly drained Okoboji soils are in the depressions. The somewhat poorly drained Nicollet soils are on low rises. The somewhat excessively drained Zenor soils are on knolls and ridgetops.

Most of this association is used for cultivated crops and livestock enterprises. Corn and soybeans are grown

on the less sloping soils. The steeper soils are used for hay and pasture.

The Clarion and Canisteo soils are well suited and the Storden soils moderately suited to all of the cultivated crops commonly grown in the county. The principal management needs are erosion control on the more sloping soils and improvement of drainage in the nearly level soils. Most of the poorly drained areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions.

3. Canisteo-Clarion-Nicollet Association

Nearly level to moderately sloping, poorly drained, well drained, and somewhat poorly drained, silty and loamy soils formed in glacial sediments and glacial till; on uplands

This association consists of nearly level soils on flats and in swales and very gently sloping to moderately sloping soils on rises, knolls, and low hills. Much of the association was marsh and intermittent ponds before drainage systems were installed. Slopes range from 0 to 9 percent.

This association makes up about 31 percent of the county. It is about 35 percent Canisteo soils, 25 percent Clarion soils, 15 percent Nicollet soils, and 25 percent minor soils.

Canisteo soils are poorly drained, are nearly level, and are on flats and in swales. Clarion soils are well drained, are gently sloping and moderately sloping, and are on knolls and side slopes. Nicollet soils are somewhat poorly drained, are very gently sloping, and are on rises.

Typically, the surface layer of the Canisteo soils is black, calcareous silty clay loam about 7 inches thick. The subsurface layer is black and very dark gray, calcareous clay loam about 13 inches thick. The subsoil is friable, calcareous clay loam about 24 inches thick. The upper part is grayish brown, and the lower part is light olive gray and mottled. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Clarion soils is black loam about 7 inches thick. The subsurface layer is very dark brown and dark brown loam about 11 inches thick. The subsoil is dark yellowish brown, friable loam about

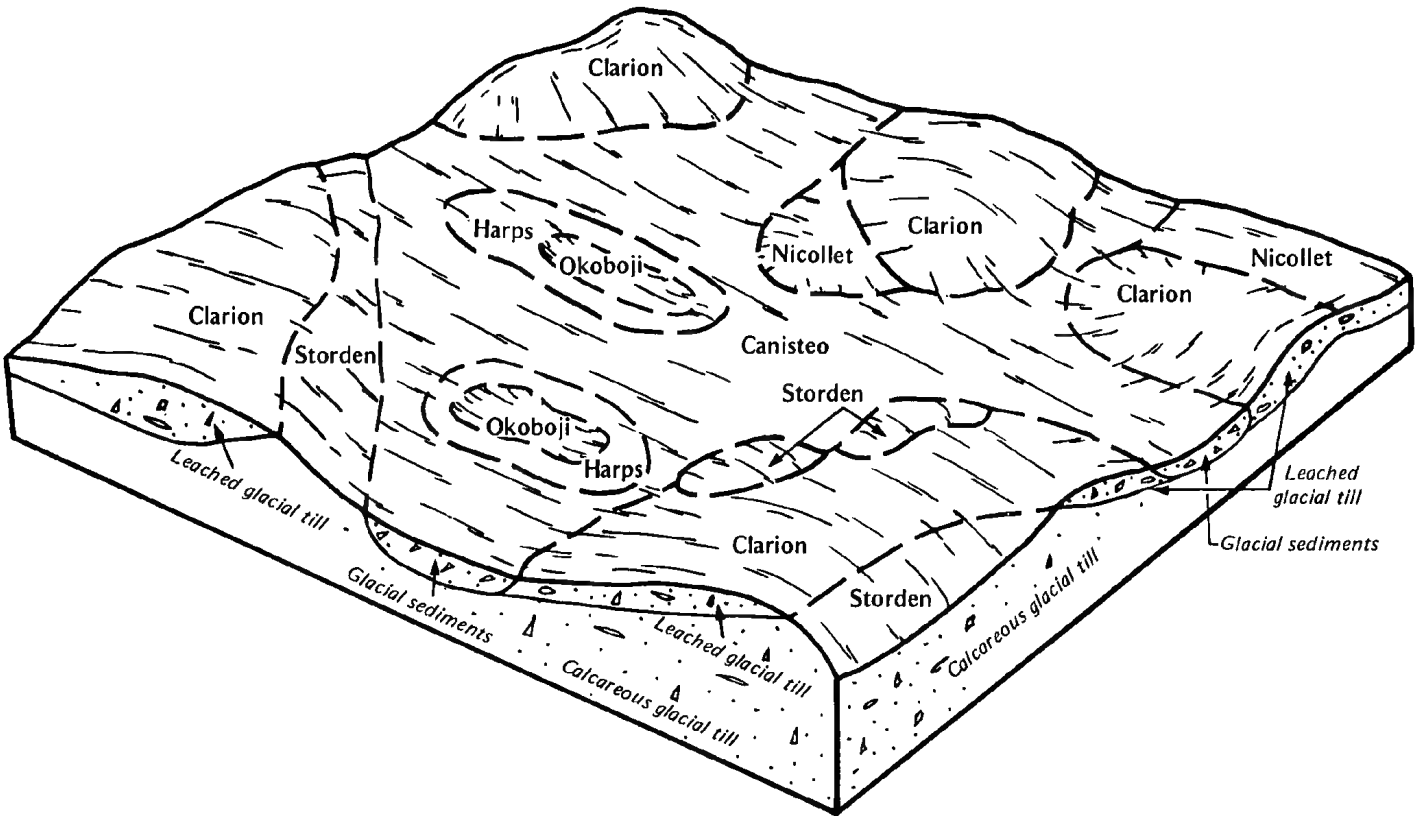


Figure 3. Typical pattern of soils and parent material in the Clarion-Canisteo-Storden association.

18 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Nicollet soils is black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 10 inches thick. The subsoil is friable loam about 18 inches thick. The upper part is dark grayish brown, and the lower part is dark grayish brown and brown and is mottled. The substratum to a depth of about 60 inches is light olive brown and grayish brown, mottled, calcareous loam.

The minor soils in this association are the poorly drained, noncalcareous Webster soils in narrow drainageways; the poorly drained, highly calcareous Harps soils around depressions; the very poorly drained Okoboji and Palms soils in the depressions; and the well drained, calcareous Storden soils on knolls and side slopes.

Most of this association is used for cultivated crops. Corn is grown year after year in the large, drained depressions. Corn and soybeans generally are grown in rotation in the rest of the association.

The soils in this association generally are well suited to all of the cultivated crops commonly grown in the county. An exception is the soils in depressional areas where controlling weeds and diseases is difficult because of a high content of organic matter and a high water table. The main concerns of management are improvement of drainage in the wetter soils and control of erosion on the more sloping soils. Most of the poorly drained areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions.

4. Canisteo-Nicollet-Webster Association

Nearly level and very gently sloping, poorly drained and somewhat poorly drained, silty and loamy soils formed in glacial sediments and glacial till; on uplands

This association consists of nearly level soils on flats and in swales and very gently sloping soils on low rises. The flats have scattered depressions that were marsh and ponds before a drainage system was installed. Slopes range from 0 to 3 percent.

This association makes up about 12 percent of the county. It is about 35 percent Canisteo soils, 25 percent Nicollet soils, 25 percent Webster soils, and 15 percent minor soils.

Canisteo and Webster soils are poorly drained, are nearly level, and are on flats and in swales. Nicollet soils are somewhat poorly drained, are very gently sloping, and are on rises.

Typically, the surface layer of the Canisteo soils is black, calcareous silty clay loam about 7 inches thick. The subsurface layer is black and very dark gray, calcareous clay loam about 13 inches thick. The subsoil is friable, calcareous clay loam about 24 inches thick. The upper part is grayish brown, and the lower part is light olive gray and mottled. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Nicollet soils is black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 10 inches thick. The subsoil is friable loam about 10 inches thick. The upper part is dark grayish brown, and the lower part is dark grayish brown and brown and is mottled. The substratum to a depth of about 60 inches is light olive brown and grayish brown, mottled, calcareous loam.

Typically, the surface layer of the Webster soils is black silty clay loam about 8 inches thick. The subsurface layer also is black silty clay loam about 8 inches thick. The subsoil is about 24 inches thick. The upper part is dark gray and olive gray, friable silty clay loam, and the lower part is light olive gray, mottled, friable clay loam. The substratum to a depth of about 60 inches is light olive gray, mottled, calcareous loam.

The minor soils in this association are the very poorly drained Okoboji and Wacousta soils in depressions; the poorly drained, highly calcareous Harps soils around the depressions; and the well drained Clarion soils on knolls and ridges.

Corn and soybeans are the principal crops grown on these intensively cultivated soils. Cash grain farming is the dominant type of farming. Hogs are raised in some small areas.

The major soils are well suited to the cultivated crops commonly grown in the county. The main concern of management is improvement of drainage. Most of the poorly drained areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions. Controlling weeds and diseases is difficult on the soils in depressions because of a high content of organic matter and a high water table. Maintaining the fertility of the Canisteo and Harps soils is a problem because these soils have a high content of lime.

5. Hayden-Storden-Hanlon Association

Nearly level to very steep, well drained and moderately well drained, loamy soils formed in glacial till and alluvium; on uplands and bottom land

This association consists of gently sloping to very steep soils on ridgetops and side slopes and nearly level soils on bottom land. Slopes range from 0 to 50 percent.

This association makes up about 7 percent of the county. It is about 30 percent Hayden soils, 30 percent Storden soils, 10 percent Hanlon soils, and 30 percent minor soils (fig. 4).

Hayden soils are well drained, are gently sloping to very steep, and are on ridgetops and side slopes. Storden soils are well drained, are moderately sloping to very steep, and are on knolls and side slopes. Hanlon soils are moderately well drained, are nearly level, and are on bottom land.

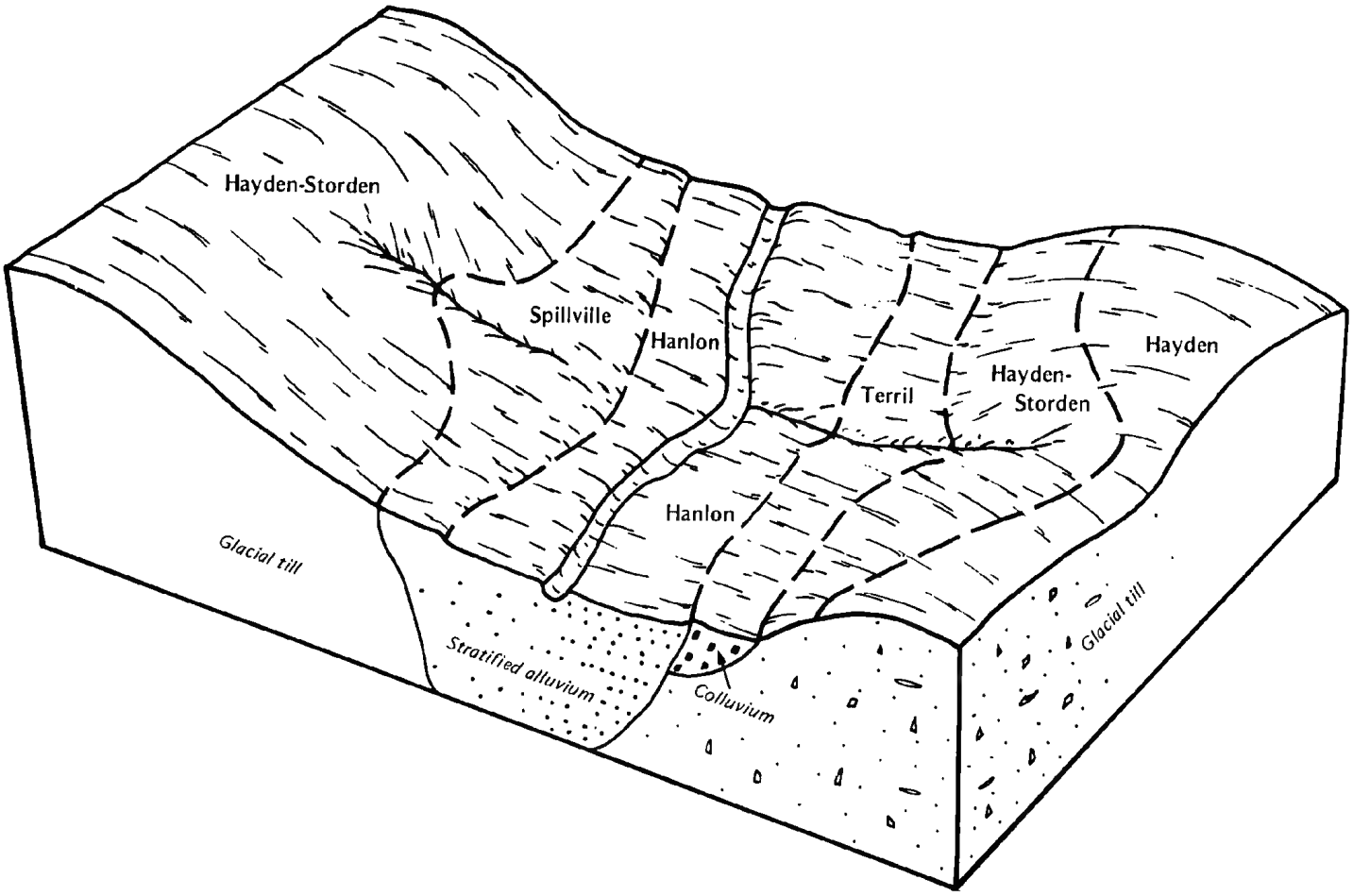


Figure 4. Typical pattern of soils and parent material in the Hayden-Storden-Hanlon association.

Typically, the surface layer of the Hayden soils is very dark gray loam about 4 inches thick. The subsurface layer is dark grayish brown loam about 7 inches thick. The subsoil is about 35 inches thick. The upper part is brown, friable loam; the next part is dark yellowish brown, firm clay loam; and the lower part is light olive brown, friable clay loam. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Typically, the surface layer of the Storden soils is dark grayish brown, calcareous loam about 6 inches thick. Plowing has mixed some streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown, mottled, and calcareous in the lower part.

Typically, the surface layer of the Hanlon soils is black fine sandy loam about 8 inches thick. The subsurface layer is black and very dark brown fine sandy loam about 47 inches thick. The subsoil to a depth of about 60 inches is very dark grayish brown, very friable fine sandy loam.

The minor soils in this association are the poorly drained Coland and somewhat poorly drained Spillville soils on bottom land, the moderately well drained Terril soils on foot slopes, and the well drained Wadena and somewhat poorly drained Cylinder soils on terraces.

Many of the steeper soils in this association are wooded. Generally, they are used for pasture rather than woodland, but a few small tracts are managed as woodland. In areas where the sloping soils can be tilled, hay is grown in rotation with corn. Including hay in the rotation helps to control erosion. Row crops are grown on the gently sloping ridgetops and on bottom land where flooding is controlled. Fields commonly are small and are irregular in shape.

The steeper soils in this association are unsuitable for cultivated crops, mainly because of the slope and the erosion hazard. The soils on bottom land and terraces, however, are well suited to cultivated crops. The

principal management concerns on bottom land are flood control and drainage. In some of the soils on terraces, available water capacity is moderate or low. These soils are slightly droughty unless summer rains are frequent.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Clarion loam, 2 to 5 percent slopes, is one of several phases in the Clarion series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Coland-Terril complex, 1 to 5 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, limestone quarry, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

4 Knoke silty clay loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland depressions. It is subject to ponding. Areas range from 2 to 10 acres in size and are elliptical.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam and clay loam about 24 inches thick. The subsoil is dark gray, friable clay loam about 12 inches thick. The substratum to a depth of about 60 inches is gray, mottled silty clay loam. This soil is calcareous throughout.

Permeability is moderately slow, and runoff is ponded. Available water capacity is very high. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 7 to 12 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The subsoil generally has a very low or low supply of available phosphorus and potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove ponded water. Tile drains remove excess subsurface water. Even if the soil is drained, special care generally is needed to maintain good tilth in the surface layer. The availability of plant nutrients is adversely affected by the excess amount of lime in the soil. In some areas where soybeans are grown, applications of ferrous sulfate or other iron compounds

are needed. Soil structure tends to be weak and breaks down if the soil is cultivated when too wet.

The wetness and the excess lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. The species that can withstand the wetness should be selected for planting. Applications of phosphorus, potassium, and minor nutrients are needed in most areas.

The land capability classification is IIIw.

6 Okoboji silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding (fig. 5). Areas dominantly are 2 to 10 acres in size but range to 50 acres. They are elliptical.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer also is black silty clay loam. It is about 20 inches thick. The subsoil is about 14 inches thick. It is mottled and friable. The upper part is olive gray and very dark gray silty clay loam, and the lower part is olive gray clay loam. The substratum to a depth of about 60 inches is olive gray, mottled clay loam.

Permeability is moderately slow, and runoff is ponded. Available water capacity is very high. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 6 to 9 percent. Reaction typically is neutral in the surface layer and neutral or mildly alkaline in the subsurface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove ponded water. Tile drains remove excess subsurface water. Special care generally is needed to maintain good tilth in the surface layer. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Cultivating when the soil is too wet causes surface compaction and cloddiness.

Figure 5. Ponding in an area of Okoboji silty clay loam, 0 to 1 percent slopes, in a small depression.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIIw.

27B Terril loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on upland foot slopes and convex alluvial fans. Slopes generally are short. Areas are irregularly shaped or are long and narrow. They generally are 2 to 5 acres in size, but a few are somewhat larger.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black, very dark brown, and very dark grayish brown loam about 25 inches thick. The subsoil to a depth of about 60 inches is brown, friable loam.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 4.5 to 5.5 percent. Reaction typically is slightly acid or neutral in the surface and subsurface layers. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. Some are used for pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. In places contour farming and terracing are difficult because slopes are short and irregular. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the infiltration rate.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIe.

27C Terril loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on slightly concave foot slopes. Areas range from 5 to 10 acres in size and are long and narrow.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 22 inches thick. The subsoil to a depth of about 60 inches is dark brown and brown, friable loam.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 4.5 to 5.5 percent. Reaction typically is neutral or slightly acid in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for pasture. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a system of conservation tillage that leaves crop residue on the surface, contour farming, or terraces or by a combination of these. The soil receives runoff from the adjacent uplands. Diversion terraces help to control the runoff and thus help to prevent the crop damage caused by the deposition of sediment. Good tilth generally can be easily maintained.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, causes surface compaction and increases the runoff rate. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

48 Knoke mucky silty clay loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in large upland depressions, many of which formerly were shallow lakes. It is subject to ponding. Areas range from 5 to more than 30 acres in size and are irregularly shaped.

Typically, the surface layer is black mucky silty clay loam about 8 inches thick. The subsurface layer is about 25 inches thick. The upper part is very dark gray mucky silty clay loam, the next part is black mucky silty clay loam, and the lower part is black silty clay loam. The subsoil is black, friable silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is gray, very dark gray, and dark gray, mottled silty clay loam. This soil is calcareous throughout.

Permeability is moderately slow, and runoff is ponded. Available water capacity is very high. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 12 to 20 percent. Reaction typically is moderately alkaline or mildly alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. An adequate subsurface and surface drainage system is needed. The availability of plant nutrients is limited by the excess amount of lime in the soil, as commonly is evidenced by stunted soybeans that have yellow leaves. Applications of phosphorus and potassium fertilizer are needed. In some areas applications of ferrous sulfate or

other iron compounds also are needed. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is wet hastens the breakdown of soil structure.

The wetness and the excess lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. The species that can withstand the wetness should be selected for planting. Applications of phosphorus, potassium, and minor nutrients are needed in most areas.

The land capability classification is IIIw.

52B Bode clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls and convex side slopes in the uplands. Slopes typically are short. Areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark brown and dark brown clay loam about 10 inches thick. The subsoil is friable clay loam about 24 inches thick. The upper part is brown, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous loam. In some areas plowing has mixed part of the subsoil with the surface soil.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 3 to 4 percent. The surface layer and subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If erosion is controlled, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

Erosion is a slight hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Temporary cover crops or surface mulch helps to control erosion.

The land capability classification is IIe.

52C Bode clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on knolls and convex side slopes in the uplands. Slopes typically are short. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown clay loam about 7 inches thick. The subsurface layer is very dark grayish brown clay loam about 4 inches thick. The subsoil is friable clay loam about 24 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is mottled dark yellowish brown, grayish brown, and light olive brown loam. In places plowing has mixed part of the subsoil with the surface soil.

Permeability is moderate, and runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer is about 3.0 to 3.5 percent. The surface layer and subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

Erosion is a moderate hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Temporary cover crops or surface mulch helps to control erosion.

The land capability classification is IIIe.

52C2 Bode clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes in the uplands. Slopes typically are short. Areas range from 5 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 7 inches thick. It is mixed with streaks and pockets of subsoil material. The subsoil is friable clay loam about 20 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown and grayish brown loam.

Included with this soil in mapping are some small areas of Storden soils, which are calcareous throughout. These soils are in the higher convex areas. They make up about 10 percent of the unit.

Permeability is moderate in the Bode soil, and runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer is about 2.0 to 2.5 percent. The surface layer and subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to corn, soybeans, and small

grain and to grasses and legumes for hay and pasture. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

Erosion is a moderate hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Temporary cover crops or surface mulch helps to control erosion.

The land capability classification is IIIe.

55 Nicollet loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on low rises and slightly concave side slopes in the uplands. Areas generally range from 2 to 15 acres in size and are oblong, but some are 50 acres or more and are irregularly shaped.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 10 inches thick. The subsoil is friable loam about 18 inches thick. It is dark grayish brown in the upper part and brown and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown and grayish brown, mottled, calcareous loam.

Included with this soil in mapping are small areas of poorly drained soils, which are lower on the landscape than the Nicollet soil. These soils make up about 10 percent of the unit.

Permeability is moderate in the Nicollet soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 5 to 6 percent. Reaction typically is slightly acid or neutral in the surface and subsurface layers. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Good tilth generally can be easily maintained. Cultivating or grazing when the soil is too wet, however, causes surface compaction. Returning crop residue to the soil or regularly adding other organic material helps to control wind erosion and prevent surface crusting and increases the infiltration rate.

The seasonal high water table is a moderate limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. It generally can be overcome, however, by selecting the species that can withstand occasional wetness or by installing a drainage system.

The land capability classification is I.

62C2 Storden loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained, calcareous soil is on knolls and convex side slopes along streams and upland drainageways. Slopes generally are short. Areas range from 2 to 10 acres in size. They are irregularly shaped or are long and narrow.

Typically, the surface layer is dark grayish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown, mottled, and calcareous in the lower part. In some areas it has strata of silt loam and sandy loam.

Included with this soil in mapping are some areas where the slope is less than 5 or more than 9 percent. These areas make up about 10 percent of the unit. Also included are some small areas of sandy or gravelly soils on knobs. These soils make up less than 5 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 1.0 to 1.5 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If erosion is controlled and fertility improved, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Erosion is a severe hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in areas where slopes are short. Applications of a large amount of phosphorus and potassium fertilizer are needed because of the high content of lime in the soil. In some areas where soybeans are grown, applications of iron compounds are needed. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

62D2 Storden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Most areas range from 2 to 10 acres in size. They are long and narrow.

Typically, the surface layer is dark grayish brown, calcareous loam about 6 inches thick. Plowing has mixed some streaks and pockets of yellowish brown

substratum material into the surface layer. The substratum to a depth of about 60 inches is light olive brown, yellowish brown, and light yellowish brown, mottled, calcareous loam. In places it has strata of sandy loam.

Included with this soil in mapping are some areas where the slope is more than 14 percent. These areas make up about 10 percent of the unit. Also included are some small areas of sandy or gravelly soils on knobs. These soils make up less than 5 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer is about 0.5 to 1.5 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for pasture. If erosion is controlled and fertility improved, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Erosion is a severe hazard (fig. 6). Much of the precipitation from intense rainfall runs off unless a plant cover protects the surface. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in areas where slopes are short and irregular. Good tilth generally can be easily maintained. In some areas where soybeans are grown, applications of iron compounds are needed. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

Pastures commonly are renovated by planting a cultivated crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

62E2 Storden loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are

Figure 6. Rill erosion on Storden loam, 9 to 14 percent slopes, moderately eroded.

short. Most areas are 2 to 10 acres in size. They are long and narrow.

Typically, the surface layer is brown, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is light olive brown, yellowish brown, and light yellowish brown, calcareous loam. In some areas it has strata of silt loam and sandy loam.

Included with this soil in mapping are some areas where the slope is less than 14 percent. These areas make up about 10 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer is about 0.5 to 1.0 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas were once used for cultivated crops but are now used for pasture. A few areas are cultivated. This soil is poorly suited to corn and soybeans. It is moderately suited to small grain and to grasses and legumes for hay and pasture. Erosion is a severe hazard if cultivated crops are grown or if pastures are overgrazed. A protective plant cover is needed because rainfall runs off rapidly. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. In many areas contour farming and terracing are difficult because the slopes are too steep and too short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

This soil is suited to row crops grown occasionally to renovate pastures. The pastures commonly are renovated by planting the row crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IVe.

62F Storden loam, 18 to 25 percent slopes. This steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Most areas range from 10 to 20 acres in size. They are long and narrow.

Typically, the surface layer is dark grayish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is light olive brown, yellowish brown, and light yellowish brown, calcareous loam.

Included with this soil in mapping are some areas where the slope is less than 18 percent. These areas make up about 10 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are used for pasture. Some support bluegrass or native grasses. Because erosion is a severe hazard, this soil is generally unsuitable for cultivated crops. It is better suited to grasses and legumes for hay and pasture, but it is too erodible for unlimited grazing. Operating farm machinery is hazardous because of the steep slope. In areas where farm machinery can be used, fertilizer can be applied and pastures renovated.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch. Planting is difficult because of the steep slope.

The land capability classification is VIe.

90 Okoboji mucky silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding. Areas are irregularly shaped. Most range from 5 to 25 acres in size, but some are 40 acres or more.

Typically, the surface layer is black mucky silty clay loam about 13 inches thick. The subsurface layer is black silty clay loam about 19 inches thick. The subsoil is very dark gray, friable silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches is dark gray silty clay loam. In places the surface layer is muck.

Permeability is moderately slow, and runoff is slow to ponded. Available water capacity is very high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 10 to 20 percent. Reaction typically is slightly acid in the surface layer and neutral or mildly alkaline in the subsurface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, small grain, and grasses. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In many areas deep cuts are needed to provide suitable outlets. In the adequately drained areas, good tilth generally can be easily maintained.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. The

species that can withstand the wetness should be selected for planting.

The land capability classification is IIIw.

95 Harps clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in plane or slightly convex areas, typically on the rims of upland depressions. Areas range from 2 to 10 acres in size and are elliptical.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is clay loam about 15 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is light olive gray, friable clay loam and loam about 17 inches thick. The substratum to a depth of about 60 inches is olive gray and olive, mottled loam. This soil is calcareous throughout.

Permeability is moderate, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 4.5 to 5.5 percent. Reaction typically is moderately alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Returning crop residue to the soil and regularly adding other organic material help to control wind erosion and prevent surface crusting and increase the infiltration rate. The availability of plant nutrients is adversely affected by the excess amount of lime in the soil. In some areas where soybeans are grown, applications of iron compounds are needed.

The seasonal high water table and the excess lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can withstand a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

96 Turlin loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on bottom land. It is subject to flooding. Areas range from 10 to 30 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 27 inches thick. The subsoil is dark grayish brown, friable loam about 11 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam. In places the surface soil is less than 24 inches thick.

Permeability is moderate, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 4.5 to 5.5 percent. Reaction typically is neutral or slightly acid in the surface and subsurface layers. The subsoil generally has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses or legumes for hay and pasture. Tile drains can improve the timeliness of fieldwork by removing excess subsurface water. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

Some areas are used for pasture or hay. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the soil and pasture in good condition.

The land capability classification is IIw.

107 Webster silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales or slightly convex areas on uplands. Most areas range from 5 to 25 acres in size and are long and narrow, but some are as large as 100 acres and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer also is black silty clay loam about 8 inches thick. The subsoil is about 24 inches thick. The upper part is dark gray and olive gray, friable silty clay loam. The lower part is light olive gray, mottled, friable clay loam. The substratum to a depth of about 60 inches is light olive gray, mottled loam. In places the surface layer is clay loam.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils in depressions. These soils make up about 5 percent of the unit.

Permeability is moderate in the Webster soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 6 to 7 percent. Reaction typically is neutral in the surface layer and subsurface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess water. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic

material helps to control wind erosion and prevent surface crusting and increases the infiltration rate.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIw.

108B Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex slopes on stream terraces. Most areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 15 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, very friable loamy coarse sand. The substratum to a depth of about 60 inches is grayish brown gravelly sand. In some areas, the surface layer is sandy loam and the slope is more than 5 percent.

Permeability is moderate in the upper part of the profile and very rapid in the lower part. Available water capacity is moderate, and runoff is medium. The content of organic matter in the surface layer is about 3 to 4 percent. The surface layer and subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Also, the soil is seasonally droughty because of the sandy and gravelly substratum. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control erosion.

If this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and increases the runoff rate and the susceptibility to erosion.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally droughty. A permanent plant cover or surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIe.

135 Coland clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land and low terraces. It is subject to flooding. Areas range from 10 to 50 acres in size and are long and narrow.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is clay loam about 31 inches thick. It is black in the upper part and very dark gray in the lower part. The upper part of the substratum is dark gray and olive gray clay loam. The lower part to a depth of about 60 inches is olive gray, mottled loam. In some places the surface layer is silty clay loam. In other places it is calcareous.

Included with this soil in mapping are small areas of sandy soils, generally at the slightly higher elevations. These soils make up about 10 percent of the unit.

Permeability is moderate in the Coland soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 5 to 7 percent. Reaction typically is slightly acid or neutral in the surface and subsurface layers. The substratum generally has a low supply of available phosphorus and a very low supply of available potassium. The shrink-swell potential is high.

Most areas are cultivated. Some areas that are not protected from flooding or that are isolated by a meandering stream are used for pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture if it is adequately drained and if flooding is controlled. Special care generally is needed to maintain good tilth in the surface layer. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Cultivating when the soil is too wet causes surface compaction and cloddiness. Returning crop residue to the soil or regularly adding other organic material helps to control wind erosion and prevent surface crusting and increases the infiltration rate. Water-tolerant grasses and legumes are the best suited pasture plants.

The seasonal high water table and the flooding are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can withstand the wetness and the flooding should be selected for planting.

The land capability classification is IIw.

138B Clarion loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls and side slopes in the uplands. Areas generally range from 2 to 10 acres in size and are long and narrow, but a few are more than 50 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark brown and dark brown loam about 11 inches thick. The subsoil is dark yellowish brown, friable loam about 18 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places plowing has mixed part of the subsoil with the surface soil. In other places the substratum has lenses of loamy sand or sand.

Included with this soil in mapping are some areas of the somewhat poorly drained Nicollet soils at the lower elevations. Also included are some small areas of sandy or gravelly soils on knobs and some areas of Storden soils, which are higher on the landscape than the Clarion soil. Included soils make up less than 15 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 3 to 4 percent. The surface layer and the subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture (fig. 7). If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIe.

138B2 Clarion loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on knolls and side slopes in the uplands. Areas range from 2 to 10 acres in size and are long and narrow.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable loam about 20 inches thick. The upper part is dark brown and brown, and the lower part is dark yellowish brown. The substratum to a

Figure 7. An area of Clarion loam, 2 to 5 percent slopes, used for crops.

depth of about 60 inches is light olive brown, calcareous loam.

Included with this soil in mapping are some small areas of sandy or gravelly soils on knobs and some areas of Storden soils, which are higher on the landscape than the Clarion soil. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 2 to 3 percent. The surface layer and the subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIe.

138C Clarion loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on knolls in the uplands and on convex side slopes along upland drainageways. Slopes typically are short. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is friable loam about 16 inches thick. It is brown in the upper part and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some concave areas near the base of slopes, the dark surface soil is as much as 24 to 30 inches thick. In places the substratum has lenses of loamy sand and sand.

Included with this soil in mapping are some small areas of sandy or gravelly soils on knobs and areas of Storden soils at the higher elevations. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 3.0 to 3.5 percent. The surface layer and the subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

138C2 Clarion loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls in the uplands and on convex side slopes along upland drainageways. Slopes typically are short. Areas range from 5 to 35 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material with the surface layer. The subsoil is friable loam about 18 inches thick. The upper part is dark brown, the next part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown and light olive brown, calcareous loam.

Included with this soil in mapping are some small areas of Storden soils, mainly on the steeper parts of the slopes. These soils make up about 5 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 2.0 to 2.5 percent. The surface layer and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss, and grassed waterways help to prevent gully erosion. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic

material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, results in surface compaction and a poor stand and increases the runoff rate.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

138D2 Clarion loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes along streams and drainageways in the uplands. Slopes typically are short. Areas are long and narrow. They generally range from 2 to 10 acres in size, but a few are larger.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material with the surface layer. The subsoil is friable loam about 14 inches thick. It is brown in the upper part and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In places the surface layer is thicker and darker.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. The surface layer and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Some areas are cultivated. Some are used for pasture. This soil is moderately suited to corn and soybeans. It is well suited to small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a severe hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. Overgrazing results in a poor plant cover and increases the runoff rate.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

168B Hayden loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex upland ridgetops and knolls. Areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray loam about 4 inches thick. The subsurface layer is dark grayish brown loam about 7 inches thick. The subsoil is about 35 inches thick. The upper part is brown, friable loam; the next part is dark yellowish brown, firm clay loam; and the lower part is light olive brown, friable clay loam. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Included with this soil in mapping are a few small areas of soils that are wetter than the Hayden soil. These soils make up about 5 percent of the map unit.

Permeability is moderate in the Hayden soil, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 1.5 to 2.5 percent. Reaction typically is slightly acid or medium acid in the surface and subsurface layers. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium.

Many areas are cultivated. Some are used for woodland. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a moderate hazard. If erosion is controlled, however, row crops can be grown in most years. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas contour farming and terracing are practical, but they are not so practical in undulating areas where slopes are short. If terraces are built, cuts should not expose the subsoil. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to maintain tilth, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, causes surface compaction and poor tilth and increases the runoff rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

A few small areas support native hardwoods. This soil is suited to trees. Seedlings survive and grow well if competing vegetation is controlled by careful site preparation or by spraying, cutting, or girdling.

The land capability classification is IIe.

168C Hayden loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex upland side slopes and ridgetops. Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown loam about 3 inches thick. The subsurface layer is grayish brown loam about 8 inches thick. The subsoil is yellowish brown, firm clay loam about 32 inches thick.

The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. Reaction typically is slightly acid or medium acid in the surface and subsurface layers. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium.

This soil is moderately suited to corn, soybeans, and small grain and well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. If erosion is controlled, however, row crops can be grown in many years. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas contour farming and terracing are practical, but they are not so practical in undulating areas where slopes are short. Tilth generally is fair in the surface layer. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. If permanent pastures are improved, the content of organic matter slowly increases. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth and increases the runoff rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

Most areas support native hardwoods. This soil is suited to trees. Formerly cultivated soils are better suited to conifers than to hardwoods. The hardwood seedlings require a better site and grow better if planted on uncultivated soils. If trees are planted, competing vegetation can be controlled by careful site preparation or by spraying or cutting.

The land capability classification is IIIe.

168C2 Hayden loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex upland side slopes and ridgetops. Areas range from 10 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown loam about 8 inches thick. Plowing has mixed some streaks and pockets of brown clay loam subsoil material into the surface layer. The subsoil is dark yellowish brown and brown, firm clay loam about 30 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, calcareous loam.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 0.5 to 1.0 percent. Reaction typically is medium acid in the surface layer and the upper part of the subsoil. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. If erosion is controlled, however, row crops can be grown in many years. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas contour farming and terracing are practical, but they are not so practical in undulating areas where slopes are short. Tilth generally is fair in the surface layer. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration. More intensive management is needed to maintain productivity and improve tilth on this soil than on the uneroded Hayden soils.

A cover of pasture plants or hay is effective in controlling erosion. If permanent pastures are improved, the content of organic matter slowly increases in this moderately eroded soil. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth and increases the runoff rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suited to trees. Eroded or formerly cultivated soils are better suited to conifers than to hardwoods. The hardwood seedlings require a better site and grow better if planted on uncultivated soils. If trees are planted, competing vegetation can be controlled by careful site preparation or by spraying or cutting.

The land capability classification is IIIe.

168E Hayden loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on convex upland side slopes. Areas range from 5 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown loam about 3 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. The subsoil is yellowish brown, firm clay loam about 24 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, calcareous loam.

Included with this soil in mapping are small areas of Storden soils on the upper side slopes. These soils are calcareous throughout. They make up less than 10 percent of the unit.

Permeability is moderate in the Hayden soil, and runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer is about 1.0 to 1.5 percent. Reaction typically is medium acid in the surface and subsurface layers. The subsoil generally has a

medium supply of available phosphorus and a low supply of available potassium.

Most areas are used for hay and pasture. This soil is poorly suited to corn, soybeans, and small grain and moderately suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces. Grassed waterways help to prevent gullying.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth and increases the runoff rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

A few small areas support native hardwoods. This soil is suited to trees. Erosion and the equipment limitation are the main management concerns. Carefully selecting sites for logging trails or roads and laying out the trails or roads on the contour or nearly on the contour help to control erosion. Because of the moderately steep slope, operating some equipment is difficult or hazardous.

The land capability classification is IVe.

175B Dickinson sandy loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on uplands and alluvial terraces. Areas range from 2 to 20 acres in size and are irregularly shaped or oval.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown sandy loam about 11 inches thick. The subsoil is about 26 inches thick. The upper part is brown and dark yellowish brown, very friable sandy loam, and the lower part is yellowish brown, very friable loamy fine sand. The substratum to a depth of about 60 inches is yellowish brown fine sand.

Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Runoff is medium. Available water capacity is moderate. The content of organic matter in the surface layer is about 1 to 2 percent. Reaction typically is slightly acid or medium acid in the surface and subsurface layers. The subsoil typically is neutral or slightly acid. It generally has a very low supply of available phosphorus and potassium. The surface layer is very friable but tends to crust after hard rains and puddle if tilled when wet.

Most areas are cultivated. Some are used for pasture or hay. Many small areas are cropped along with larger areas of adjacent soils that are better suited to crops. This soil is moderately suited to corn, soybeans, and small grain and to grasses or legumes for hay and pasture. Droughtiness is a limitation in most years unless rainfall is timely. Also, wind erosion is a hazard in areas where cultivated crops are grown. Blowing sand grains sometimes damage newly seeded crops on this soil and on the adjoining soils unless the surface is protected by a plant cover. A system of conservation tillage that leaves crop residue on the surface, cover crops, and grassed waterways help to prevent excessive soil loss. The soil is poorly suited to terracing because ridging the moderately coarse textured material is difficult and because the underlying coarse textured material is too close to the surface. If terraces are built, cuts should not expose the coarse textured material in terrace channels. The soil warms up quickly in the spring, thus stimulating early plant growth. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the available water capacity.

If this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and causes deterioration of the plant community. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during excessively wet or dry periods help to keep the pasture and the soil in good condition.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIe.

175C Dickinson sandy loam, 5 to 9 percent slopes. This moderately sloping, somewhat excessively drained soil is on convex upland slopes and stream terraces. Areas range from 4 to 20 acres in size and are broad and irregularly shaped.

Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The subsurface layer also is very dark brown sandy loam. It is about 5 inches thick. The subsoil is about 38 inches thick. The upper part is brown and dark yellowish brown, very friable sandy loam, and the lower part is yellowish brown, very friable sandy loam and loamy sand. The substratum to a depth of about 60 inches is yellowish brown loamy sand. In places loamy glacial till is at a depth of 40 inches or more.

Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Runoff is medium. Available water capacity is moderate. The content of organic matter in the surface layer is about 1.0 to 1.5 percent. Reaction typically is medium acid or slightly acid in the surface and subsurface layers. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated or used for hay and pasture. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. They can be controlled by stripcropping, a system of conservation tillage that leaves crop residue on the surface, contour farming,

terraces, or a combination of these. The soil is droughty during periods of below normal rainfall. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material conserves moisture, improves fertility, and helps to maintain tilth.

If this soil is used for pasture, overgrazing causes surface compaction and increases the runoff rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during dry periods help to keep the pasture and the soil in good condition.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

201B Coland-Terril complex, 1 to 5 percent slopes. These nearly level and gently sloping soils are on alluvial fans and along narrow drainageways in the uplands. The poorly drained Coland soil is near stream channels and is subject to flooding. The moderately well drained Terril soil is at the base of upland slopes along the boundary of the mapped areas. Areas range from 5 to 30 acres in size and are long and narrow. They are about 50 percent Coland soil and 40 percent Terril soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Coland soil has a surface layer of black clay loam about 9 inches thick. The subsurface layer is also black clay loam. It is about 20 inches thick. The subsoil is very dark gray, friable clay loam about 18 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled loam.

Typically, the Terril soil has a surface layer of very dark brown loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 24 inches thick. The subsoil to a depth of about 60 inches is dark brown and brown, friable loam.

Included with these soils in mapping are small areas in depressions that are subject to ponding. These areas make up about 5 to 10 percent of the unit.

Permeability is moderate in the Coland and Terril soils. Runoff is slow on the Coland soil and medium on the Terril soil. Available water capacity is high in both soils. The Coland soil has a seasonal high water table. The content of organic matter is about 5.0 to 7.0 percent in the surface layer of the Coland soil and 4.5 to 5.5 percent in the surface layer of the Terril soil. The surface layer of both soils typically is neutral or slightly acid. The subsoil of the Coland soil generally has a low supply of available phosphorus and a very low supply of available potassium. The subsoil of the Terril soil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. The shrink-swell potential is high in the Coland soil.

Most areas are cultivated. Many small areas are cropped along with the adjacent areas. Some areas are used for pasture. These soils are well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Wetness and brief flooding are the main limitations. Some areas receive runoff from side slopes and thus are subject to siltation. Diversions and channel improvement help to control floodwater and the runoff from the adjacent side slopes. Grassed waterways help to control erosion and prevent gullying. A drainage system improves the timeliness of fieldwork and helps to maintain tilth.

If these soils are used for pasture, overgrazing or grazing during wet periods causes surface compaction and reduces the rate of water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

The land capability classification is IIw.

203 Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on stream terraces. Slopes generally are plane or concave but in places are slightly convex. Areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark brown loam about 10 inches thick. The subsoil is dark grayish brown, friable loam about 19 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled gravelly coarse sand. In some areas it is loamy sand or sand in which the content of gravel is less than 5 percent.

Permeability is moderate in the upper part of the profile and very rapid in the lower part. Runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 4 to 5 percent. The surface layer and subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated (fig. 8). This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It has a high water table during wet periods but becomes droughty after fairly brief dry periods. Tile drains generally are not needed because of the droughtiness during much of the growing season. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control wind erosion.

Drought is a hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Generally, the trees and shrubs that can withstand the seasonal wetness as well as the droughtiness should be selected for planting. A surface

Figure 8. Soybeans on Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes.

mulch conserves moisture. Almost any species suited to the climate can be grown if a drainage system is installed to reduce the wetness and if irrigation water is applied as needed to overcome the droughtiness.

The land capability classification is IIs.

221 Palms muck, 0 to 1 percent slopes. This level, very poorly drained soil is in depressions on uplands. It is subject to ponding. Areas dominantly are 10 to 40 acres in size but range to 300 acres. They are circular.

Typically, the surface layer is black muck about 7 inches thick. The subsurface layer also is black muck. It is about 39 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown, mottled silty clay loam.

Included with this soil in mapping are soils in which the organic material is less than 16 inches thick. These soils are in positions on the landscape similar to those of the Palms soil. They make up about 15 percent of the unit.

The Palms soil is moderately rapidly permeable in the organic layers and moderately permeable in the substratum. It has a seasonal high water table near or above the surface. Available water capacity is very high. The content of organic matter is more than 20 percent in the surface layer. Reaction typically is neutral to moderately alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If properly drained by tile, this soil is moderately suited to corn, soybeans, and specialty crops and to grasses for hay and pasture. Undrained areas are well suited to wildlife habitat. Small grain tends to lodge on this soil. Legumes commonly are winterkilled or drowned. If cultivated crops are grown, wind erosion is a hazard. Winter cover crops and a system of conservation tillage that leaves crop residue on the surface throughout the year help to prevent excessive soil loss. Early frost can damage crops in the fall. The soil is subject to subsidence, which should be

considered when the depth of drainage tile is determined.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks and ornamental plantings. It can be overcome by installing a drainage system and by selecting water-tolerant species for planting.

The land capability classification is IIIw.

236B Lester loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls and convex side slopes along streams in the uplands. Areas are irregularly shaped. They generally are 2 to 10 acres in size, but a few are larger than 20 acres.

Typically, the surface layer is very dark brown loam about 9 inches thick. The subsoil is about 38 inches thick. The upper part is dark yellowish brown, friable loam; the next part is dark yellowish brown and yellowish brown, firm clay loam; and the lower part is light olive brown, mottled, friable clay loam. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam.

Included with this soil in mapping are some areas of nearly level, somewhat poorly drained soils. These soils make up about 5 percent of the unit.

Permeability is moderate in the Lester soil, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 2 to 3 percent. The surface layer and the upper part of the subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Some areas are used for wooded pasture. Some are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in most areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting grazing improves the quality of the woodland.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIe.

236C2 Lester loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes along streams in the uplands. Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. Plowing has mixed some streaks and pockets of dark yellowish brown clay loam subsoil material into the surface layer. The subsoil is dark yellowish brown and yellowish brown clay loam about 30 inches thick. It dominantly is firm, but in the upper few inches it is friable. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In uncultivated areas, the surface layer is very dark gray loam about 5 inches thick and the subsurface layer is dark grayish brown loam about 6 inches thick.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. The surface layer and the upper part of the subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. Some are used for pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in most areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting grazing improves the quality of the woodland.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

259 Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained soil generally is in low lying areas on stream terraces. In a few places, however, it is in outwash areas on uplands. Areas are irregularly shaped. They generally

range from 5 to 20 acres in size, but some are 40 acres or more.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black and very dark gray clay loam about 11 inches thick. The upper part of the subsoil is olive gray, friable clay loam about 10 inches thick. The lower part is grayish brown loam about 9 inches thick. The substratum to a depth of about 60 inches is grayish brown sandy loam, loamy sand, and gravelly sand.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 5 to 7 percent. Reaction typically is neutral in the surface layer and mildly alkaline or neutral in the subsurface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It not only is seasonally wet but also is slightly droughty during some periods because of the gravelly substratum. Tile drains remove excess water. In some years, however, the drainage system removes the water that the crop needs later in the growing season. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control wind erosion.

The seasonal high water table is the main limitation if this soil is used for trees and shrubs grown as windbreaks or ornamental plantings, but the droughtiness also is a limitation in some years. Almost any species suited to the climate can be grown if a drainage system is installed to reduce the wetness and irrigation water is applied as needed to overcome the droughtiness.

The land capability classification is IIw.

288 Ottosen clay loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on slightly convex knolls in the uplands. Areas generally range from 2 to 10 acres in size, but a few are 25 acres or more. They are irregularly shaped.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 6 inches thick. The subsoil is dark grayish brown, mottled, friable clay loam about 17 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam and clay loam. In places the subsoil has thin layers of silty clay.

Permeability is moderately slow in the upper part of the profile and moderate in the lower part. Available water capacity is high, and runoff is slow. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 5 to 6 percent. Reaction typically is neutral or slightly acid in the surface and subsurface layers. The subsoil generally has a very low or low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The seasonal wetness can delay fieldwork, but it can be overcome by installing tile drains. Good tilth generally can be easily maintained. Cultivating or grazing when the soil is wet, however, causes surface compaction. Returning crop residue to the soil or regularly adding other organic material helps to control erosion and prevent surface crusting and increases the infiltration rate.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. It generally is a slight limitation, and most of the commonly grown trees and shrubs can be planted.

The land capability classification is I.

308 Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is on slightly convex slopes on stream terraces. Most areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 10 inches thick. The subsoil is about 17 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, very friable sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly sand.

Included with this soil in mapping are some areas of sandy and gravelly soils on small knobs and some small areas of poorly drained soils on the low lying parts of the landscape. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the lower part. Available water capacity is moderate, and runoff is slow. The content of organic matter in the surface layer is about 3 to 4 percent. The surface layer and subsurface layer typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control wind erosion.

If this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and increases the susceptibility to wind erosion.

The seasonal droughtiness is the main limitation if this soil is used for trees and shrubs grown as windbreaks or ornamental plantings. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIs.

355 Luther loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is in plane or slightly convex areas on uplands. Areas are irregular in shape. They generally range from 5 to 20 acres in size, but a few are 50 acres or more.

Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown silt loam about 4 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, friable and firm clay loam about 37 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam.

Included with this soil in mapping are areas of poorly drained soils, which are lower on the landscape than the Luther soil. These soils make up about 15 percent of the unit.

Permeability is moderately slow in the Luther soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 2 to 3 percent. Reaction typically is slightly acid or medium acid in the surface and subsurface layers. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In periods of above average rainfall, a few of the more level areas are wet. In these areas a drainage system improves the timeliness of fieldwork. Good tilth generally can be easily maintained in the surface layer.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and reduces the rate of water infiltration. Restricted use during wet periods helps to keep the pasture and the soil in good condition.

Some areas support native hardwoods. The hazards or limitations that affect planting are slight if the proper species are selected for planting and competing vegetation is controlled or removed.

The land capability classification is I.

356G Storden-Hayden loams, 25 to 50 percent slopes. These very steep, well drained soils are on upland side slopes adjacent to the major streams (fig. 9). The landscape generally is dissected by many gullies and deep drainageways. The calcareous Storden soil is on west- and south-facing slopes. The Hayden soil is on north- and east-facing side slopes and ridgetops. Areas range from 5 to 30 acres in size and are irregular in shape. They are about 40 percent Storden loam and 40 percent Hayden loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Storden soil has a surface layer of dark brown, calcareous loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, mottled, calcareous loam.

Typically, the Hayden soil has a surface layer of very dark grayish brown loam about 3 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil is about 24 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, friable loam and clay loam. The substratum to a depth of about 60 inches is yellowish brown, friable, calcareous loam.

Included with these soils in mapping are some areas of severely eroded soils. Also included are small areas of gravelly outwash, which has a lower available water capacity than the Storden and Hayden soils. Included areas make up less than 20 percent of the unit.

The Storden and Hayden soils are moderately permeable. Runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. Reaction typically is slightly acid or neutral in the surface layer of the Hayden soil and is mildly or moderately alkaline in the surface layer of the Storden soil. The substratum in the Storden soil has a very low supply of available phosphorus and potassium. The subsoil in the Hayden soil has a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are used as woodland or permanent pasture. These soils are moderately suited to trees, poorly suited to pasture, and well suited to woodland wildlife habitat. They are not suitable for cultivation. A few areas have been cleared for pasture, but forage production is low. Erosion is a severe hazard unless the surface is protected by a good plant cover.

Erosion is a severe hazard if these soils are used for the trees and shrubs grown as windbreaks and ornamental plantings. It can be controlled by temporary cover crops or a cover of mulch. The better quality native trees can be left on the site in areas where they are desirable.

The land capability classification is VIIe.

388 Kossuth silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flats and in swales and low gradient drainageways. Areas generally range from 5 to 40 acres in size and are long and narrow, but a few are 100 acres or more and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is also black silty clay loam. It is about 10 inches thick. The subsoil is

Figure 9. A wooded area of Storden-Hayden loams, 25 to 50 percent slopes.

olive gray, friable silty clay loam and clay loam about 20 inches thick. It is mottled and calcareous in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils in depressions. These soils make up less than 5 percent of the unit.

Permeability is moderately slow in the upper part of the Kossuth soil and moderate in the lower part. Available water capacity is high, and runoff is slow. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 6 to 7 percent. Reaction typically is slightly acid or neutral in the surface and subsurface layers. The subsoil generally has a low or very low supply of available phosphorus and potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the infiltration rate. Returning crop residue to the soil or regularly adding other organic material helps to control wind erosion and prevent surface crusting and increases the infiltration rate.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The species that can withstand the wetness should be selected for planting, or a drainage system should be installed.

The land capability classification is IIw.

485 Spillville loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on bottom land. It is subject to flooding. Areas range from 5 to about 20 acres in size and are long and narrow.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black, very dark brown, very dark gray, and very dark grayish brown loam about 44 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam. In places the surface layer is sandy loam.

Permeability is moderate, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 5 to 6 percent. Reaction typically is neutral or slightly acid in the surface and subsurface layers. The subsurface layer generally has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses or legumes for hay or pasture. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

Some areas are used for pasture or hay. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The land capability classification is IIw.

506 Wacousta silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding. Areas are irregularly shaped. They generally range from 10 to 40 acres in size, but a few are as large as 70 acres.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is also black silty clay loam. It is about 4 inches thick. The subsoil is olive gray, mottled, calcareous, friable silty clay loam about 7 inches thick. The upper part of the substratum is olive gray, mottled, calcareous silty clay loam. The lower part to a depth of about 60 inches is mottled light olive gray, strong brown, and dark brown, calcareous silty clay loam and silt loam. In some places the surface layer is mucky silty clay loam. In other places the substratum has lenses of loamy sand and sand.

Permeability is moderate, and runoff is ponded. Available water capacity is very high. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 8 to 10 percent. Reaction typically is neutral in the surface layer and neutral or mildly alkaline in the subsurface layer. The subsoil generally has a very low supply of available phosphorus and potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In many areas deep cuts are needed to provide suitable outlets. Good tilth generally is difficult to maintain. Cultivating when the soil is too wet causes cloddiness and a poor seedbed.

The seasonal high water table is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. Only the species that can withstand the wetness should be selected for planting.

The land capability classification is IIIw.

507 Canisteo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on flats and in irregularly shaped swales and low gradient drainageways on uplands. Areas are irregularly shaped. They generally range from 10 to 100 acres in size, but a few are 300 acres or more.

Typically, the surface layer is black, calcareous silty clay loam about 7 inches thick. The subsurface layer is black and very dark gray, calcareous clay loam about 13 inches thick. The subsoil is friable, calcareous clay loam about 24 inches thick. The upper part is grayish brown, and the lower part is light olive gray and mottled. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam. In places the surface layer is not calcareous.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils in depressions and the highly calcareous Harps soils around the depressions. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Canisteo soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 6 to 7 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic material helps to control wind erosion and prevent surface crusting and increases the infiltration rate. The high content of lime in the soil adversely affects the availability of plant nutrients. The only varieties of soybeans that should be planted are those that are resistant to iron chlorosis.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings.

Only the species that can tolerate a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

508 Calcousta silty clay loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland depressions. It is subject to ponding. Areas are irregularly shaped. They generally range from 10 to 20 acres in size, but a few are as large as 70 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is also black silty clay loam. It is about 5 inches thick. The subsoil is olive gray, mottled, friable silty clay loam about 11 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. This soil is calcareous throughout. In some places the surface layer is mucky silty clay loam. In other places the substratum has lenses of loamy sand and sand.

Permeability is moderate, and runoff is ponded. Available water capacity is very high. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 8 to 10 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In many areas deep cuts are needed to provide suitable outlets. Good tilth generally is difficult to maintain. Cultivating when the soil is too wet causes cloddiness and a poor seedbed.

The seasonal high water table is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. Only the species that can withstand the wetness should be selected for planting.

The land capability classification is IIIw.

511 Blue Earth mucky silt loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland basins that were formerly shallow lakes. It is subject to ponding. Areas range from 100 to 300 acres in size and are irregular in shape.

Typically, the surface layer is very dark gray mucky silt loam about 9 inches thick. The subsurface layer is very dark grayish brown and dark gray, mottled mucky silt loam about 19 inches thick. The substratum to a depth of about 60 inches is dark gray silt loam. This soil is calcareous throughout.

Permeability is moderate, and runoff is ponded. Available water capacity is high. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 12 to 15 percent. Reaction typically is moderately alkaline throughout the profile. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn and small grain and to grasses and legumes for hay and pasture. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In some areas deep cuts are needed to provide suitable outlets. Cultivating when the soil is too wet causes cloddiness and a poor seedbed. Because of the excess amount of lime and the high content of organic matter, controlling weeds is difficult.

The seasonal high water table is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or as plantings that enhance wildlife habitat. A drainage system is needed. Only the species that can withstand the wetness and the calcareous conditions should be selected for planting.

The land capability classification is IIIw.

536 Hanlon fine sandy loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on bottom land. It is subject to flooding. Areas generally are 5 to 40 acres in size and are elongated.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsurface layer is black and very dark brown fine sandy loam about 47 inches thick. The subsoil to a depth of about 60 inches is very dark grayish brown, very friable fine sandy loam.

Included with this soil in mapping are small areas of excessively drained, stratified, sandy soils. If cropped, these soils are droughty. They make up about 5 to 10 percent of the unit.

Permeability is moderately rapid in the Hanlon soil, and runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 2 to 3 percent. Reaction typically is slightly acid or neutral in the surface and subsurface layers. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately protected from flooding, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Levees and dikes help to control the floodwater. Good tilth generally can be easily maintained.

Pastured areas are easily overstocked because the available water capacity is only moderate. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The land capability classification is IIs.

559 Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in concave areas on stream terraces. Areas range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam and clay loam about 14 inches thick. The subsoil is about 16 inches thick. The upper part is dark grayish brown, mottled, friable clay loam, and the lower part is olive gray, friable, mottled sandy clay loam. The substratum to a depth of about 60 inches is olive gray gravelly loamy coarse sand. This soil is calcareous throughout.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 6 to 7 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Some areas are cultivated, and some are used for pasture. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It not only is seasonally wet but also is slightly droughty during some periods because the available water capacity is very low in the sandy and gravelly substratum. Tile drains remove excess subsurface water. In some years, however, the drainage system removes the water that the crop needs later in the growing season. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. The high content of lime in the soil adversely affects the availability of some of the plant nutrients. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic material helps to control wind erosion and prevent surface crusting and increases the infiltration rate. The only varieties of soybeans that should be planted are those that are resistant to iron chlorosis.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can withstand a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

638C2 Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded. These moderately sloping, well drained soils are on knobs, ridgetops, and side slopes in the uplands. Slopes typically are short. The Clarion soil is on ridgetops and the lower side slopes, and the calcareous Storden soil is on knobs and the upper side slopes. Areas are about 60 percent Clarion soil and 40 percent Storden soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 8 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable loam about 16 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Typically, the Storden soil has a surface layer of dark grayish brown, calcareous loam about 8 inches thick. Plowing has mixed some streaks and pockets of light olive brown substratum material into the surface layer. The substratum to a depth of about 60 inches is light olive brown and yellowish brown, calcareous loam.

Permeability is moderate in both soils, and runoff is medium. Available water capacity is high. The content of organic matter is about 2.0 to 2.5 percent in the surface layer of the Clarion soil and 1.0 to 1.5 percent in the surface layer of the Storden soil. Reaction typically is slightly acid or neutral in the surface layer and upper part of the subsoil in the Clarion soil. It is mildly alkaline in the surface layer and upper part of the substratum in the Storden soil. The subsoil of the Clarion soil and the substratum of the Storden soil generally have a very low supply of available phosphorus and potassium.

Most areas are cultivated. Some are used for pasture. These soils are moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss, and grassed waterways help to prevent gully erosion. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, results in surface compaction and a poor stand and increases the runoff rate. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soils in good condition.

If these soils are used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

828B Zenor sandy loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on upland knolls and side slopes in glacial outwash areas. Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is dark brown sandy loam about 5 inches thick. The subsoil is brown and dark yellowish brown, very friable sandy loam about 20 inches thick. The substratum to a depth of about 60 inches is yellowish brown loamy sand and gravelly loamy sand.

Included with this soil in mapping are a few small areas of the calcareous Storden soils. These soils are in positions on the landscape similar to those of the Zenor soil. They make up about 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Zenor soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The content of organic matter in the surface layer is about 2 to 3 percent. Reaction typically is neutral or slightly acid in the surface and subsurface layers. The subsoil generally has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It tends to be droughty. A system of conservation tillage that leaves crop residue on the surface, contour farming, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and conserves moisture.

If this soil is used for pasture, overgrazing increases the runoff rate. Proper stocking rates and pasture rotation help to keep the pasture and the soil in good condition.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

828C2 Zenor sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, somewhat excessively drained soil is on upland knolls and side slopes in glacial outwash areas. Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is brown and yellowish brown, very friable sandy loam about 20 inches thick. It contains fine gravel. The substratum to a depth of about 60 inches is yellowish brown and brownish yellow gravelly loamy sand.

Included with this soil in mapping are a few small areas of the calcareous Storden soils. These soils are in positions on the landscape similar to those of the Zenor soil. They make up about 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Zenor soil and rapid in the lower part. Runoff is medium. Available water capacity is moderate. The content of organic matter in the surface layer is about 1.0 to 1.5 percent. Reaction typically is neutral or slightly acid in the surface layer and the upper part of the subsoil. The subsoil generally has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It tends to be droughty. A system of conservation tillage that leaves crop residue on the surface, contour farming, stripcropping, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Tilth generally is fair in the surface layer. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and conserves moisture. More intensive management is needed to maintain productivity and improve tilth on this soil than on the uneroded Zenor soils.

If this soil is used for pasture, overgrazing increases the runoff rate. Proper stocking rates and pasture rotation help to keep the pasture and the soil in good condition.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IIIe.

829D2 Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on side slopes and knolls in glacial outwash areas on uplands (fig. 10). The somewhat excessively drained Zenor soil makes up about 60 percent of the map unit, and the well drained, calcareous Storden soil makes up about 40 percent. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical. Areas are irregular in shape and range from 2 to 25 acres in size.

Typically, the Zenor soil has a surface layer of dark brown sandy loam about 7 inches thick. Some streaks and pockets of dark yellowish brown subsoil material are mixed with the surface layer. The subsoil is dark yellowish brown, very friable sandy loam about 20 inches thick. The substratum to a depth of 60 inches is yellowish brown gravelly coarse sand.

Typically, the Storden soil has a surface layer of dark brown, calcareous loam about 7 inches thick. Some streaks and pockets of yellowish brown substratum material are mixed with the surface layer. The substratum to a depth of 60 inches is yellowish brown and brownish yellow, calcareous loam.

Permeability is moderately rapid in the upper part of the Zenor soil and rapid in the lower part. It is moderate

Figure 10. Typical area of Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded.

in the Storden soil. Runoff is medium on both soils. Available water capacity is moderate in the Zenor soil and high in the Storden soil. The content of organic matter is about 0.5 to 1.5 percent in the surface layer of both soils. The surface layer of the Zenor soil typically is slightly acid or neutral. The Storden soil is mildly alkaline or moderately alkaline throughout. The supply of available phosphorus is low in the subsoil of the Zenor soil and very low in the Storden soil. The supply of available potassium is very low in both soils.

Most areas are cultivated. Some are used for pasture. These soils are poorly suited to corn, soybeans, and small grain. They are moderately suited to grasses and legumes for hay and pasture. Erosion is a severe hazard. It can be controlled, however, by contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and conserves moisture.

A cover of pasture plants or hay is effective in controlling erosion. Pastures commonly are renovated by planting a cultivated crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is IVe.

829E2 Zenor-Storden complex, 14 to 18 percent slopes, moderately eroded. These moderately steep soils are on side slopes and knolls in glacial outwash

areas. The somewhat excessively drained Zenor soil makes up about 60 percent of the map unit, and the well drained, calcareous Storden soil makes up about 40 percent. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical. Areas are irregular in shape and range from 2 to 15 acres in size.

Typically, the Zenor soil has a surface layer of dark brown sandy loam about 6 inches thick. Some streaks and pockets of dark yellowish brown subsoil material are mixed with the surface layer. The subsoil is dark yellowish brown, very friable sandy loam about 16 inches thick. The substratum to a depth of about 60 inches is yellowish brown gravelly coarse sand.

Typically, the Storden soil has a surface layer of dark brown, calcareous loam about 6 inches thick. Some streaks and pockets of yellowish brown substratum material are mixed with the surface layer. The substratum to a depth of about 60 inches is yellowish brown and brownish yellow, calcareous loam.

Permeability is moderately rapid in the upper part of the Zenor soil and rapid in the lower part. It is moderate in the Storden soil. Runoff is rapid on both soils. Available water capacity is moderate in the Zenor soil and high in the Storden soil. The content of organic matter is about 0.5 to 1.0 percent in the surface layer of both soils. The surface layer of the Zenor soil typically is slightly acid or neutral. The Storden soil is mildly alkaline or moderately alkaline throughout. The supply of available phosphorus is low in the subsoil of the Zenor soil and very low in the Storden soil. The supply of available potassium is very low in both soils.

Most areas are in pasture or hay. Some of the small areas are managed along with adjoining cultivated areas. These soils are moderately suited to grasses and legumes for hay and pasture. They are generally unsuited to cultivated crops because of the slope, low productivity, and a severe hazard of erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and conserves moisture.

A cover of pasture plants or hay is effective in controlling erosion. Pastures commonly are renovated by planting a cultivated crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch.

The land capability classification is VIe.

956 Harps-Okoboji complex, 0 to 1 percent slopes. These nearly level soils are on uplands. The poorly drained, calcareous Harps soil is on the rims of depressions. The very poorly drained Okoboji soil is in the depressions. It is subject to ponding. Areas are irregular in shape and range from 5 to more than 300 acres in size. They are about 45 percent Harps soil and 40 percent Okoboji soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Harps soil has a surface layer of black clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 12 inches thick. The subsoil is light olive gray and olive gray, mottled, friable loam about 21 inches thick. The substratum to a depth of about 60 inches is light olive gray, mottled loam. This soil is calcareous throughout.

Typically, the Okoboji soil has a surface layer of black silty clay loam about 8 inches thick. The subsurface layer is also black silty clay loam. It is about 24 inches thick. The subsoil is dark gray and gray, mottled, friable silty clay loam about 15 inches thick. The substratum to a depth of about 60 inches is light gray and gray, mottled silty clay loam.

Included with these soils in mapping are small areas of the poorly drained, calcareous Canisteo soils on flats and in swales. These soils make up about 15 percent of the unit.

Permeability is moderate in the Harps soil, and runoff is slow. Permeability is moderately slow in the Okoboji soil, and runoff is ponded. Both soils have a seasonal high water table. Available water capacity is high in the Harps soil and very high in the Okoboji soil. The content of organic matter is about 4.5 to 5.5 percent in the surface layer of the Harps soil and 9 to 12 percent in the surface layer of the Okoboji soil. Reaction typically is moderately alkaline throughout the Harps soil. It is neutral in the surface layer of the Okoboji soil and neutral or mildly alkaline in the upper part of the subsoil. The subsoil of both soils has a very low supply of available phosphorus and potassium. The Okoboji soil has a high shrink-swell potential.

Most areas are cultivated. If adequately drained, these soils are moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove ponded water. Tile drains remove excess subsurface water. Cultivating when the soil is too wet causes surface compaction and cloddiness. Returning crop residue to the soil helps to control wind erosion and prevent surface crusting and increases the infiltration rate. The availability of plant nutrients is adversely affected by the excess amount of lime in the Harps soil. In some areas where soybeans are grown, applications of iron compounds are needed. The only varieties of soybeans that should be planted are those that are resistant to iron chlorosis.

The seasonal high water table and the excess lime are the main limitations if these soils are used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. Only the

species that can withstand a wet, calcareous soil should be selected for planting.

The land capability classification is IIIw.

1221 Palms muck, ponded, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland depressions. It is subject to ponding. Areas range from 2 to 10 acres in size and are circular.

Typically, a few inches of partly decomposed plant residue is at the surface. The surface layer is black muck about 10 inches thick. The subsurface layer is also black muck. It is about 20 inches thick. The subsoil is about 13 inches thick. The upper part is very dark gray, friable silt loam, and the lower part is very dark gray, friable silty clay loam. The substratum to a depth of about 60 inches is very dark gray and olive gray clay loam. This soil is calcareous throughout.

Permeability is moderately rapid in the upper organic layers and moderate in the lower part of the profile. Runoff is ponded. Available water capacity is very high. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 20 to 40 percent. Reaction typically is moderately alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and potassium.

This soil supports aquatic vegetation. It is suited to wetland wildlife habitat. The trees and shrubs planted in areas of wildlife habitat should be tolerant of an extremely wet soil.

Unless an extensive drainage system is installed, this soil is not suited to cultivated crops or to grasses and legumes for hay and pasture. It also is unsuited to most trees and shrubs.

The land capability classification is Vw.

1507 Brownton silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on flats and in shallow swales and low gradient drainageways on uplands. Areas range from 10 to 100 acres in size and are irregularly shaped.

Typically, the surface layer is black, calcareous silty clay loam about 9 inches thick. The subsurface layer is calcareous silty clay about 13 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is dark gray and olive gray, mottled, firm silty clay about 16 inches thick. The substratum to a depth of about 60 inches is olive gray, calcareous, mottled clay loam. In places the surface layer is not calcareous.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils in depressions. These soils make up about 10 percent of the unit.

Permeability is slow in the Brownton soil, and runoff is slow to ponded. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 6 to 7 percent. Reaction typically is mildly alkaline or moderately alkaline throughout the profile. The subsoil generally has a very low supply of available phosphorus and potassium. The shrink-swell potential is high.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic material helps to control wind erosion and prevent surface crusting and increases the infiltration rate. The high content of lime in the soil adversely affects the availability of plant nutrients. In some areas where soybeans are grown, applications of iron compounds are needed.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can tolerate a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

1536 Hanlon fine sandy loam, channeled, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on natural levees and first bottoms. It is subject to flooding. Areas generally are more than 25 acres in size and are elongated.

Typically, the surface layer is very dark brown fine sandy loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown fine sandy loam about 30 inches thick. The subsoil is very dark grayish brown, very friable sandy loam about 15 inches thick. The substratum to a depth of about 60 inches is dark grayish brown sandy loam. In places the soil is overlain by recently deposited, stratified, sandy sediments.

Included with this soil in mapping are small areas of Coland and Spillville soils. These soils have more clay throughout than the Hanlon soil and are wetter. They make up about 20 percent of the unit.

Permeability is moderately rapid in the Hanlon soil, and runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter in the surface layer is about 2 to 3 percent. The surface and subsurface layers typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are used as woodland or pasture. This soil generally is unsuited to cultivated crops because of the flooding hazard. Levees and dikes help to control the floodwater. Tile drains function satisfactorily if adequate outlets are available.

Pastured areas are easily overstocked because the available water capacity is only moderate. The soil is somewhat droughty during extended dry periods. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The land capability classification is Vw.

1585 Spillville-Coland complex, channeled, 0 to 2 percent slopes. These nearly level soils are on flood plains dissected by meandering stream channels. They are subject to flooding. The Spillville soil is somewhat poorly drained, and the Coland soil is poorly drained. Areas range from 5 to 30 acres in size and are long and narrow. They are about 50 percent Spillville soil and 35 percent Coland soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Spillville soil has a surface layer of black loam about 8 inches thick. The subsurface layer is black, very dark brown, and very dark grayish brown, friable loam about 30 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam.

Typically, the Coland soil has a surface layer of black clay loam about 8 inches thick. The subsurface layer is clay loam about 39 inches thick. It is black in the upper part and gray in the lower part. The substratum to a depth of about 60 inches is olive gray clay loam.

Included with these soils in mapping are areas of Hanlon soils. These included soils contain more sand than the Spillville and Coland soils. They are in positions on the landscape similar to those of the Spillville and Coland soils. They make up about 15 percent of the unit.

Permeability is moderate in the Spillville and Coland soils, and surface runoff is slow. These soils have a seasonal high water table. Available water capacity is high. The shrink-swell potential is high in the Coland soil. The content of organic matter is about 4 to 5 percent in the surface layer of the Spillville soil and 5 to 7 percent in the surface layer of the Coland soil. Reaction typically is neutral or slightly acid in the surface and subsurface layers of both soils. The subsoil generally has a low supply of available phosphorus and very low supply of available potassium.

Most areas are pastured (fig. 11). A few areas are far from the present stream channel and are not frequently flooded. These soils generally are unsuited to cultivated crops but are moderately suited to pasture. Overgrazing or grazing during wet periods causes surface compaction and reduces the rate of water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

The land capability classification is Vw.

2225 Blue Earth mucky silt loam, sandy substratum, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland basins that were formerly shallow lakes. It is subject to ponding. Areas range from 50 to 100 acres in size and are irregular in shape.

Typically, the surface layer is black and very dark gray mucky silt loam about 24 inches thick. The subsurface layer is dark gray silt loam about 18 inches thick. The substratum to a depth of about 60 inches is grayish brown and olive gray loamy sand. This soil is calcareous throughout. In places the depth to coarse material is less than 24 inches.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Runoff is ponded. Available water capacity is moderate. A seasonal high water table is near or above the surface. The content of organic matter in the surface layer is about 12 to 15 percent. Reaction typically is moderately alkaline throughout the profile. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn and small grain and to grasses and legumes for hay and pasture. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In some areas deep cuts are needed to provide suitable outlets. Cultivating when the soil is too wet causes cloddiness and a poor seedbed. Because of the excess amount of lime and the high content of organic matter, controlling weeds is difficult.

The seasonal high water table is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or as plantings that enhance wildlife habitat. A drainage system is needed. Only the species that can withstand the wetness and the calcareous conditions should be selected for planting.

The land capability classification is IIIw.

4000 Urban land. This map unit is on nearly level bottom land and nearly level and gently sloping uplands and terraces in and around Webster City. Areas range from 5 to more than 30 acres in size and are rectangular or irregularly shaped.

This map unit is covered by streets, parking lots, buildings, shopping centers, and other structures that so obscure or alter the soils that identification of the soil series is not feasible. In many areas the structures are built on cut or fill material that ranges from 2 to more than 4 feet or more in thickness. Most areas are drained by sewer systems, gutters, and drainage tile.

No land capability classification is assigned.

5010 Pits, sand and gravel. This map unit dominantly is on stream terraces but in some areas is on uplands. The pits generally are no longer mined. They range from less than 1 acre to more than 40 acres in size and commonly are square or rectangular.

Typically, available water capacity is low or very low in the soil material. As a result, the material tends to be

Figure 11. A pastured area of Spillville-Coland complex, channeled, 0 to 2 percent slopes.

droughty during much of the growing season. In most areas it has a seasonal high water table. Also, the low lying areas are ponded during wet periods. Stones and cobbles are commonly on the surface. The content of organic matter in the surface layer is less than 1 percent. Reaction typically is moderately alkaline.

Most of the inactive pits support weeds and small trees. Some have been used as refuse dumps. The pits can be developed for wildlife or recreational uses. The trees and shrubs that can withstand a high content of lime and the droughtiness should be selected for planting.

No land capability classification is assigned.

5030 Pits, limestone quarry. This map unit consists of pits or mines from which limestone has been quarried, primarily for use in road construction and as agricultural lime. The pits are 40 feet or more deep and are surrounded by piles of spoil 15 feet or more high. They range from a few acres to 40 acres in size and are irregularly shaped. Some contain water a few to many feet deep and have steep sides.

The spoil surrounding the pits varies in texture but generally is loamy and contains varying amounts of limestone fragments. It is derived from glacial till, eolian material, or a mixture of the two. In some areas it has been leveled and smoothed, but in other areas it is very uneven. In the leveled areas grasses or trees grow

reasonably well. The spoil ranges from medium acid to mildly alkaline.

The quarries are suited to wildlife habitat. Those containing water could support fish. Because of the steepness of the sides and the variable depth of the water, however, they could be dangerous as sites for recreation. Onsite investigation is needed to determine the best land use.

No land capability classification is assigned.

5040 Orthents, loamy. These nearly level to strongly sloping soils are used as borrow areas for construction. In some areas the original soil has been removed to a depth of 5 to 20 feet or more, and in other areas 4 to 10 inches of topsoil has been redistributed, commonly in an uneven pattern. The soils range from excessively drained to moderately well drained, depending on the kind of material from which the soils were derived and the extent to which the borrow area is restored. Areas typically range from 6 to 50 acres in size.

Typically, the upper 60 inches is yellowish brown, friable and firm loam. In many places cobbles and pebbles are on the surface. In other places the texture is sandy loam. The surface color ranges from very dark gray to dark brown.

Included with these soils in mapping are small areas of sand. Also included are a few areas that were once dumps or landfills and are now covered.

Permeability varies in the Orthents, depending on the texture and density of the soil material. Runoff is slow to rapid. Available water capacity is moderate or low. Soil that was once buried 5 to 20 feet or more beneath the surface has less pore space and a higher density than the original surface layer. It has not been appreciably affected by the processes of soil formation, such as freezing and thawing. The content of organic matter is very low unless the topsoil has been redistributed over the area. As a result, preparing a good seedbed is difficult and drought is a hazard. Reaction typically is moderately alkaline. In most areas these soils have a very low supply of available phosphorus and potassium.

These soils are better suited to small grain and to grasses and legumes for hay and pasture than to row crops. They are suited to row crops only in some areas where the topsoil has been redistributed. Corn and soybeans are grown in these areas. If cultivated crops are grown, erosion is a moderate or severe hazard in the more sloping areas. A system of conservation tillage that turns over as little soil as possible and leaves crop residue on the surface helps to control erosion and tends to stabilize the soils.

No land capability classification is assigned.

5043 Aquents, loamy, reclaimed, 0 to 2 percent slopes. These nearly level, poorly drained soils are in areas disturbed by construction and roadbuilding. The areas generally are adjacent to highway overpasses and have been used as borrow areas. They range from 5 to 80 acres in size and are square.

The soil material varies, but most areas have 6 to 10 inches of dark topsoil. Typically, the surface layer is loam or clay loam. Generally, most of the subsoil has been removed. The next layer is calcareous, loamy glacial till.

These soils are slowly permeable. Runoff is slow. Available water capacity is generally low. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. Reaction is typically neutral or slightly acid in the surface layer and moderately alkaline in the substratum. The supply of available phosphorus and potassium is very low. Internal drainage is poor.

Most areas are used for cultivated crops. A few areas are used for hay or pasture. These soils are moderately suited to corn and soybeans. Tile drainage helps to remove excess water. Chisel plowing in the fall helps to break up the surface and thus improves water infiltration. Cultivating when the soils are wet causes compaction and cloddiness.

No land capability classification is assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 305,870 acres in Hamilton County, or nearly 83 percent of the total acreage, meets the soil requirements for prime farmland. Areas of this land are throughout the county. Approximately 300,000 acres of the prime farmland is used for crops. The crops grown on this land, mainly corn and soybeans, account for most of the county's total agricultural income each year.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 324,000 acres in Hamilton County, or 88 percent of the total acreage, is used for crops. The main crops are corn and soybeans and some oats and legume and grass-legume hay. Minor crops include sudangrass, which is used for pasture, and sorghum, which is mainly harvested for grain. The pastured acreage has decreased markedly in recent years as grain production has increased.

Extending the latest technology to all of the cropland in the county could increase crop production and the extent of soil conservation. This soil survey, which gives the basic characteristics of each kind of soil, can greatly aid in the application of such technology. The paragraphs that follow describe the management concerns that affect the use of the soils in the county for crops and pasture.

Soil drainage is a major management concern on about 50 percent of the acreage in Hamilton County. Many soils are poorly drained or very poorly drained. A drainage system is needed if these soils are cultivated. Biscay, Brownton, Canisteo, Coland, Kossuth, and Webster soils are poorly drained, and Knoke, Okoboji, Palms, and Wacousta soils are very poorly drained. Biscay and Talcot soils are underlain by sand and gravel. They are on terraces. Coland soils are on bottom land. The nearly level Brownton, Canisteo, Kossuth, and Webster soils are on uplands. Knoke, Okoboji, Palms, and Wacousta soils are in depressions.

Subsurface tile is the main method of drainage. It drains excess water into large drainage ditches, which outlet into natural streams (fig. 12). Shallow ditches are used to drain some of the soils in depressions.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drains or a system that controls the runoff from the higher lying slopes and drainage tile is needed in many areas of the somewhat poorly drained and poorly drained soils that are intensively row cropped. The drains should be more closely spaced in moderately slowly permeable or slowly permeable soils than in the more

Figure 12. A drainage ditch through an area of Canisteo silty clay loam, 0 to 2 percent slopes. Drainage ditches provide outlets for subsurface tile.

rapidly permeable soils. Finding adequate outlets for tile drainage systems is difficult in many areas.

Water erosion is a hazard on the more sloping soils, such as Bode, Clarion, Lester, and Storden soils. Contour farming and terracing or a conservation tillage system that leaves a protective amount of crop residue on the surface helps to control erosion. Some slopes are so short, steep, and irregular, however, that contour farming or terracing is not practical. On these soils a cropping system that provides a protective plant cover or a conservation tillage system is needed.

Wind erosion is a hazard on Dickinson soils unless the surface is protected. It can damage these soils in a few hours if winds are strong and the soils are dry and have no plant cover or surface mulch. Crops on these soils and the adjacent heavier textured soils are often damaged by windblown sand. Many of the nearly level, heavier textured soils, such as Brownton, Canisteo, Harps, and Webster soils, also are damaged by wind erosion (fig. 13). The damage generally occurs when these soils are cropped to soybeans and then fall plowed. Maintaining a plant cover or a surface mulch and keeping the surface rough through proper tillage minimize the damage caused by wind erosion on all of the soils.

Loss of the surface layer through erosion is damaging for many reasons. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into a plow layer. The damage is especially serious if the soil has a restricted root zone. Erosion can result in the pollution of streams by sediment. Control of erosion improves the quality of water for municipal use, for recreation, and for fish and wildlife by minimizing this pollution.

Measures that control erosion provide a protective plant cover, reduce the runoff rate, and increase the

infiltration rate. A cropping system that keeps a plant cover on the surface for extended periods can hold soil losses to an amount that will not reduce the productive capacity of the soils. On livestock farms, where part of the acreage is pasture and hayland, including legumes and grasses in the cropping sequence not only provides nitrogen and improves tilth for the following crop but also reduces the risk of erosion on the more sloping soils.

A system of conservation tillage that leaves a protective amount of crop residue on the surface is effective in controlling erosion. Following are examples of conservation tillage systems. No-till is a system in which the seedbed is prepared and the seed planted in one operation. The surface is disturbed only in the immediate area of the planted seed row. A protective cover of crop residue is left on at least 90 percent of the surface. Strip till or till-plant also is a system in which the seedbed is prepared and the seed planted in one operation. Tillage is limited to a strip not wider than one-third of the row width. A protective cover is left on two-thirds of the surface after planting. Both the no-till and strip till or till-plant systems can be adapted to most of the soils in the survey area. They are less effective, however, on soils that have a clayey surface layer. Chisel-disk or rotary tillage is a system in which the soil is loosened throughout the field and part of the crop residue is incorporated into the soil. Preparing the seedbed and planting may be one of several operations.

Ridge-till planting is a system that includes both no-till and strip till on ridges. The crops are planted on ridges 4 to 6 inches higher than the area between the rows. On poorly drained soils, ridge-till planting may improve early seedbed conditions, thus allowing timely planting. A combination of herbicides and cultivation helps to control weeds.

Soil fertility varies widely in the soils in Hamilton County. Most of the well drained soils on uplands are naturally acid, but Storden soils are alkaline. The poorly drained soils generally are neutral or alkaline. Applications of ground limestone are needed before plants can grow well on the acid soils. The supply of available potash and phosphorus varies widely. It is particularly low in Harps and other wet, alkaline soils. On all soils additions of lime and fertilizer should be based

Figure 13. Siltation caused by wind erosion in an area where the surface is not protected.

on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime needed.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous and generally high in content of organic matter. Regular additions of crop residue, manure, and other organic material improve soil structure and help to prevent surface crusting.

Fall plowing is not recommended on many of the soils in Hamilton County. The more sloping soils and many of the nearly level soils that have been cropped to soybeans are subject to damaging erosion if they are fall plowed.

The *field crops* suited to the soils and climate of Hamilton County include many that are not commonly grown. Corn and soybeans are the most commonly grown crops. Oats is the most common close-growing crop. Wheat, grain sorghum, sunflowers, potatoes, sugar beets, popcorn, pumpkins, sugar cane, canning peas, and sweet corn can be grown if economic conditions are favorable. Rye, barley, buckwheat, and flax could be grown, and grass seed could be produced from bromegrass, redtop, bluegrass, switchgrass, big bluestem, and indiangrass.

The *specialty crops* that are grown commercially in Hamilton County are limited in extent. Most of the well drained soils are suitable for orchards. Soils in low positions where frost is frequent and drainage is poor, however, generally are poorly suited to early vegetables, small fruits, and orchards. The latest information about growing specialty crops can be obtained from local offices of the Cooperative Extension Service.

Pasture and hay crops that are suited to the soils and climate of the county include several legumes, cool-season grasses, and warm-season grasses (fig. 14). Bromegrass, bluegrass, and orchardgrass are commonly grown in areas used for permanent pasture. Other cool-season grasses that are well adapted to the county include tall fescue, timothy, and reed canarygrass.

Alfalfa and red clover are the common legumes grown for hay. They are also used in mixtures with orchardgrass, bromegrass, or timothy for hay and pasture. Birdsfoot trefoil is used in mixtures with bluegrass, orchardgrass, bromegrass, or tall fescue for pasture. Other legumes that are suitable for pasture are crownvetch, ladino, and alsike clover.

The warm-season grasses adapted to the county are switchgrass, big bluestem, and indiangrass. These grasses grow well during the warm summer months. A special management system is needed, however, to establish the grasses and to keep the pasture in good condition during periods of grazing.

Good grazing management is necessary in all pastured areas. Measures that prevent surface compaction and gully erosion are especially important on steeply sloping soils. Applications of fertilizer, weed and brush management, rotation or deferred grazing, proper stocking rates, and adequate livestock watering facilities are needed on established stands. If cultivated crops are to be grown prior to seeding, soil losses can be reduced by a system of conservation tillage, contour farming, and grassed waterways. Also, interseeding grasses and legumes into the existing sod eliminates the need for destroying the vegetative cover during seedbed preparation.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in

Figure 14. Beef cattle grazing on an improved pasture of grasses and legumes.

grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, reduce energy requirements, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and

are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, orchardgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild

herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made

for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of calcium carbonate affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted,

and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease

of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, and bedrock.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or of organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage may be adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

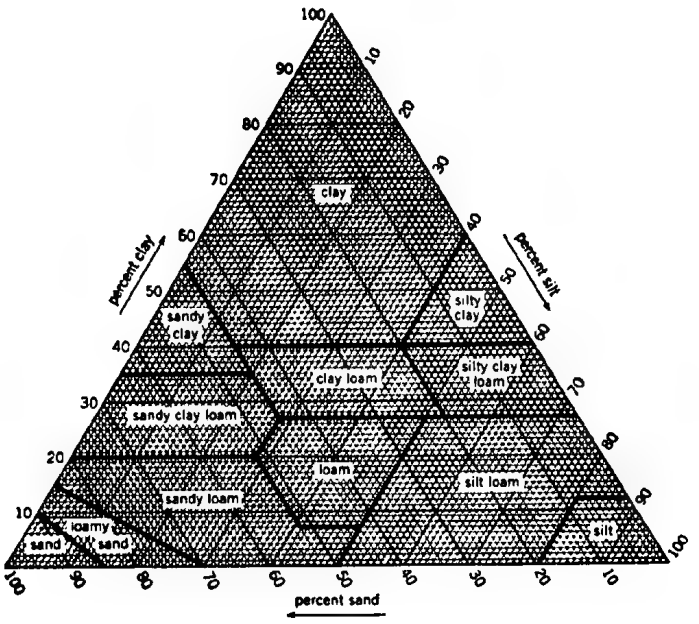


Figure 15. Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 15). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of

grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to

buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to wind erosion.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams and by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*16*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed (calcareous), mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*15*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*16*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Biscay Series

The Biscay series consists of poorly drained soils on stream terraces. These soils formed in alluvium underlain by sand and gravel. Permeability is moderate in the solum and rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Biscay soils are similar to Talcot soils and are commonly adjacent to Cylinder, Talcot, and Wadena soils. Talcot soils have a calcareous solum. Cylinder soils are somewhat poorly drained and are in slightly convex areas. Wadena soils are well drained and are in convex areas.

Typical pedon of Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 125 feet east and 1,910 feet south of the northwest corner of sec. 30, T. 88 N., R. 25 W.

Ap 0 to 9 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
A1 9 to 15 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.
A2 15 to 20 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; black (N 2/0) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg 20 to 30 inches; olive gray (5Y 5/2) clay loam; discontinuous very dark gray (5Y 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
BCg 30 to 39 inches; grayish brown (2.5Y 5/2) loam; weak fine granular structure; friable; mildly alkaline; gradual smooth boundary.
2Cg1 39 to 46 inches; grayish brown (2.5Y 5/2) loamy sand; single grained; very friable; about 5 percent gravel; few soft accumulations (calcium carbonates); slight effervescence; mildly alkaline; clear wavy boundary.
2Cg2 46 to 60 inches; grayish brown (2.5Y 5/2) gravelly sand; single grained; loose; about 15 percent gravel; few soft accumulations (calcium carbonates); strong effervescence; moderately alkaline.

The thickness of the solum, the depth to sand and gravel, and the depth to free carbonates range from 32 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches. The content of clay in the solum ranges from 18 to 30 percent. The solum is slightly acid to mildly alkaline.

The A horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 1 or less. It is loam or clay loam. The Bg horizon also is loam or clay loam. It has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loamy sand, loamy coarse sand, sand, or gravelly sand in which the content of gravel varies. This horizon is commonly stratified.

Blue Earth Series

The Blue Earth series consists of very poorly drained, moderately permeable, calcareous soils in upland basins that were formerly shallow lakes. These soils formed in highly decomposed organic material and in the underlying lacustrine and glacial till sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Blue Earth soils are commonly adjacent to Canisteo and Zenor soils. Canisteo soils contain more clay than the Blue Earth soils and have a lower organic matter content. Zenor soils contain more sand and gravel in the solum than the Blue Earth soils. They are somewhat excessively drained and are on the more sloping escarpments.

Typical pedon of Blue Earth mucky silt loam, 0 to 1 percent slopes; 2,820 feet west and 710 feet north of the southeast corner of sec. 19, T. 87 N., R. 24 W.

Ap 0 to 9 inches; very dark gray (10YR 3/1) mucky silt loam, gray (10YR 6/1) dry; weak medium subangular blocky structure; very friable; violent effervescence; few snail shells; moderately alkaline; gradual smooth boundary.
A1 9 to 13 inches; very dark grayish brown (10YR 3/2) mucky silt loam, gray (10YR 6/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; violent effervescence; few snail shells; moderately alkaline; gradual wavy boundary.
A2 13 to 20 inches; dark gray (10YR 4/1) mucky silt loam, light gray (10YR 7/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; very friable; violent effervescence; few snail shells; moderately alkaline; clear wavy boundary.
A3 20 to 28 inches; dark gray (10YR 4/1) mucky silt loam, gray (10YR 6/1) dry; few fine distinct brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; friable; violent effervescence; moderately alkaline; gradual wavy boundary.
2C1 28 to 35 inches; dark gray (10YR 4/1) silt loam; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual wavy boundary.
2C2 35 to 60 inches; dark gray (10YR 4/1) silt loam; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 25 to 60 inches in thickness. It is mildly alkaline or moderately alkaline. The thickness of the mollic epipedon ranges from 20 to 48 inches. The content of clay in the 10- to 40-inch control section ranges from 18 to 35 percent.

The content of organic matter in the A horizon is 10 to 25 percent. This horizon has hue of 10YR to 5Y, value of 2 to 4, and chroma of 2 or less. It is mucky silt loam or mucky silty clay loam. The 2C horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 2 or less. It is loam, silt loam, or silty clay loam.

Bode Series

The Bode series consists of well drained, moderately permeable soils on knobs, ridges, and convex side slopes in the uplands. These soils formed in glacial or lacustrine sediments and in the underlying glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Bode soils are similar to Clarion soils and are commonly adjacent to Brownton, Kossuth, and Ottosen soils. Clarion soils have less clay and more sand in the solum than the Bode soils. Brownton and Kossuth soils are poorly drained and are in wide swales and drainageways. Ottosen soils are somewhat poorly drained and are on low rises.

Typical pedon of Bode clay loam, 2 to 5 percent slopes; 1,700 feet west and 200 feet north of the center of sec. 14, T. 89 N., R. 25 W.

Ap 0 to 8 inches; black (10YR 2/1) clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A 8 to 13 inches; very dark brown (10YR 2/2) clay loam (29 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AB 13 to 18 inches; dark brown (10YR 3/3) clay loam (33 percent clay), brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1 18 to 29 inches; brown (10YR 4/3) clay loam (38 percent clay); discontinuous dark brown (10YR 3/3) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2 29 to 36 inches; brown (10YR 4/3) clay loam (33 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

BC 36 to 42 inches; grayish brown (2.5Y 5/2) clay loam (29 percent clay); common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.

2C 42 to 60 inches; light brownish gray (2.5Y 6/2) loam (24 percent clay); common medium prominent yellowish brown (10YR 5/8) mottles; massive; friable; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 50 inches. The thickness of the A horizon ranges from 6 to 18 inches. The content of clay in the 10- to 40-inch control section ranges from 28 to 35 percent. The solum is neutral or slightly acid.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 10YR or 2.5Y and value and chroma of 3 or 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 8.

Brownton Series

The Brownton series consists of poorly drained, slowly permeable, calcareous soils on uplands. These soils are on flats, in irregularly shaped swales surrounding depressions, and in low gradient drainageways. They formed in glacial or lacustrine sediments and in the underlying glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Brownton soils are similar to Canisteo soils and are commonly adjacent to Bode, Kossuth, and Ottosen soils. Canisteo soils have more sand and less clay in the solum than the Brownton soils. Bode, Kossuth, and Ottosen soils have a noncalcareous solum. Bode soils are well drained and are on ridges and convex side slopes. Kossuth soils are in narrow drainageways. Ottosen soils are somewhat poorly drained and are on low rises.

Typical pedon of Brownton silty clay loam, 0 to 2 percent slopes; 400 feet east and 100 feet south of the northwest corner of sec. 3, T. 86 N., R. 25 W.

Ap 0 to 9 inches; black (N 2/0) silty clay loam (38 percent clay), black (10YR 2/1) dry; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A1 9 to 17 inches; black (10YR 2/1) silty clay (42 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A2 17 to 22 inches; very dark gray (10YR 3/1) silty clay (42 percent clay), dark gray (10YR 4/1) dry; weak medium subangular blocky structure; firm; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg1 22 to 30 inches; dark gray (10YR 4/1) silty clay (42 percent clay); common fine distinct olive gray (5Y 5/2) mottles; weak fine subangular blocky structure; firm; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg2 30 to 38 inches; olive gray (5Y 5/2) silty clay (42 percent clay); common fine prominent strong brown (7.5YR 5/6) and common fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; few soft accumulations (calcium carbonates); strong effervescence; moderately alkaline; gradual smooth boundary.

2Cg 38 to 60 inches; olive gray (5Y 5/2) clay loam (33 percent clay); common coarse prominent strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 24 to 44 inches in thickness. It is mildly alkaline or moderately alkaline. The thickness of the mollic epipedon ranges from 12 to 24 inches. The content of clay in the 10- to 40-inch control section ranges from 35 to 45 percent.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 1 or less. It is silty clay loam or silty clay. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 or 2. The 2Cg horizon has hue of 2.5Y or 5Y and value of 5 or 6. It is clay loam or loam.

Calcousta Series

The Calcousta series consists of very poorly drained, moderately permeable, calcareous soils in upland basins and depressions. These soils formed in lacustrine sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Calcousta soils are similar to Wacousta soils and are commonly adjacent to Canisteo, Harps, and Palms soils. Wacousta soils have a noncalcareous solum. Canisteo and Harps soils contain more sand and less silt than the Calcousta soils. They are poorly drained. Canisteo soils are in broad swales, and Harps soils are on the rims of depressions. Palms soils formed in sapric material and in the underlying lacustrine sediments. They are in upland basins.

Typical pedon of Calcousta silty clay loam, 0 to 1 percent slopes; 1,200 feet west and 1,840 feet south of the northeast corner of sec. 9, T. 89 N., R. 23 W.

Ap 0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A 8 to 13 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt wavy boundary.

Bg 13 to 24 inches; olive gray (5Y 5/2) silt loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; clear wavy boundary.

Cg1 24 to 33 inches; olive gray (5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2 33 to 60 inches; olive gray (5Y 5/2) silty clay loam; common medium faint yellowish brown (10YR 5/4) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 10 to 24 inches in thickness. It is mildly alkaline or moderately alkaline. The thickness of the mollic epipedon ranges from 8 to 18 inches. The content of clay in the 10- to 40-inch control section ranges from 24 to 35 percent.

The A horizon is neutral in hue or has hue of 10YR. It has chroma of 1 or less. It is silty clay loam, silt loam, or mucky silt loam. The Bg horizon has value of 4 to 6 and chroma of 1 or 2. It is silty clay loam or silt loam. The Cg horizon has value of 5 or 6 and chroma of 1 or 2. It is clay loam, silty clay loam, or silt loam.

Canisteo Series

The Canisteo series consists of poorly drained, moderately permeable, calcareous soils on uplands. These soils are on flats, in irregularly shaped swales surrounding small depressions, and in low gradient drainageways. They formed in glacial sediments. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Canisteo soils are similar to Brownton soils and are commonly adjacent to Clarion, Nicollet, and Webster soils. Brownton soils contain more clay and less sand in the solum than the Canisteo soils. Clarion, Nicollet, and Webster soils have a noncalcareous solum. Clarion soils are well drained and are on ridges and convex side slopes. Nicollet soils are somewhat poorly drained and are on low rises. Webster soils are in narrow drainageways.

Typical pedon of Canisteo silty clay loam, 0 to 2 percent slopes; 1,950 feet west and 85 feet north of the southeast corner of sec. 21, T. 88 N., R. 23 W.

Ap 0 to 7 inches; black (10YR 2/1) silty clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A1 7 to 12 inches; black (10YR 2/1) clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

A2 12 to 20 inches; very dark gray (10YR 3/1) clay loam (33 percent clay), dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bg1 20 to 30 inches; grayish brown (2.5Y 5/2) clay loam (33 percent clay); few fine distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; friable; common very dark gray (10YR 3/1) tongues; slight effervescence; mildly alkaline; clear smooth boundary.

Bg2 30 to 44 inches; light olive gray (5Y 5/2) clay loam (33 percent clay); common medium prominent brownish yellow (10YR 6/8) mottles; weak medium subangular blocky structure; friable; few gray (10YR

5/1) tongues; strong effervescence; moderately alkaline; clear smooth boundary.
Cg 44 to 60 inches; olive gray (5Y 5/2) loam (24 percent clay); common medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 20 to 50 inches in thickness. It is mildly alkaline or moderately alkaline. The thickness of the mollic epipedon ranges from 14 to 24 inches. The content of clay in the 10- to 40-inch control section ranges from 28 to 35 percent.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 1 or less. It is loam, clay loam, or silty clay loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or silty clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is clay loam or loam.

Clarion Series

The Clarion series consists of well drained, moderately permeable soils on knobs, ridges, and convex side slopes in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 14 percent.

Clarion soils are similar to Bode soils and are commonly adjacent to Canisteo, Nicollet, and Webster soils. Bode soils have more clay and less sand in the solum than the Clarion soils. Canisteo and Webster soils are poorly drained and are in wide swales and drainageways. Nicollet soils are somewhat poorly drained and are on low rises.

Typical pedon of Clarion loam, 2 to 5 percent slopes; 40 feet west and 240 feet north of the southeast corner of sec. 32, T. 86 N., R. 25 W.

Ap 0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
A1 7 to 12 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
A2 12 to 18 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; continuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few small pebbles; slightly acid; gradual smooth boundary.
Bw1 18 to 26 inches; dark yellowish brown (10YR 4/4) loam; discontinuous dark brown (10YR 3/3) coatings on faces of peds; weak fine subangular blocky structure; friable; few small pebbles; neutral; gradual smooth boundary.
Bw2 26 to 36 inches; dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; few small pebbles; neutral; gradual smooth boundary.
C1 36 to 52 inches; yellowish brown (10YR 5/4) loam; few fine distinct yellowish brown (10YR 5/6) and few fine distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; few small pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.
C2 52 to 60 inches; yellowish brown (10YR 5/4) loam; common fine distinct yellowish brown (10YR 5/6) and common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; few small pebbles; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 42 inches. The thickness of the mollic epipedon ranges from 6 to 18 inches. The content of clay in the 10- to 40-inch control section ranges from 18 to 28 percent. The solum is slightly acid to mildly alkaline.

The A horizon has value of 2 or 3 and chroma of 1 to 3. The Bw horizon has value of 4 or 5 and chroma of 3 or 4. It is loam or clay loam. The C horizon ranges from sandy loam to clay loam.

Coland Series

The Coland series consists of poorly drained, moderately permeable soils on bottom land and in upland drainageways. These soils formed in alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Coland soils are commonly adjacent to Hanlon, Spillville, and Terril soils. Hanlon soils are moderately well drained, and Spillville soils are somewhat poorly drained. Hanlon and Spillville soils contain more sand and less clay in the solum than the Coland soils. They are in positions on bottom land similar to those of the Coland soils. Terril soils are moderately well drained and are on foot slopes.

Typical pedon of Coland clay loam, 0 to 2 percent slopes; 1,420 feet west and 2,640 feet north of the southeast corner of sec. 34, T. 89 N., R. 25 W.

Ap 0 to 8 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.
A1 8 to 17 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A2 17 to 31 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
AC 31 to 39 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak fine

subangular blocky structure; friable; neutral; gradual smooth boundary.
Cg1 39 to 45 inches; dark gray (5Y 4/1) and olive gray (5Y 5/2) clay loam; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Cg2 45 to 51 inches; olive gray (5Y 5/2) clay loam; massive; friable; neutral; gradual smooth boundary.
Cg3 51 to 60 inches; olive gray (5Y 5/2) loam; few fine faint light olive brown (2.5Y 5/4) mottles; massive; friable; neutral.

The solum ranges from 36 to 48 inches in thickness. It is slightly acid or neutral. The depth to free carbonates is 48 inches or more. The mollic epipedon is 36 or more inches thick. The content of clay in the 10- to 40-inch control section ranges from 27 to 35 percent.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 1 or less. It is clay loam or silty clay loam. The AC horizon also is clay loam or silty clay loam. It is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 to 4 and chroma of 1 or less. Some pedons have a Bg horizon instead of an AC horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 2 to 5, and chroma of 1 or 2. It ranges from clay loam to sandy loam.

Cylinder Series

The Cylinder series consists of somewhat poorly drained soils in slightly convex areas on stream terraces. These soils formed in alluvium underlain by sand and gravel. Permeability is moderate in the solum and very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Cylinder soils are similar to Wadena soils and are commonly adjacent to Biscay, Talcot, and Wadena soils. Biscay and Talcot soils are poorly drained and are in concave areas. Wadena soils are well drained and are at the higher elevations.

Typical pedon of Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 1,700 feet south and 900 feet west of the northeast corner of sec. 12, T. 89 N., R. 26 W.

Ap 0 to 8 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
A 8 to 18 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
Bw1 18 to 27 inches; dark grayish brown (10YR 4/2) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bw2 27 to 37 inches; dark grayish brown (10YR 4/2) loam; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.
2C1 37 to 51 inches; olive brown (2.5Y 4/4) gravelly coarse sand; few fine distinct red (2.5YR 4/6) and few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 15 percent gravel; few soft accumulations (calcium carbonates); slight effervescence; mildly alkaline; abrupt wavy boundary.
2C2 51 to 60 inches; olive brown (2.5Y 4/4) gravelly coarse sand; common medium distinct yellowish brown (10YR 5/6) and few coarse prominent dark red (2.5YR 3/6) mottles; single grained; loose; about 25 percent gravel; few soft accumulations (calcium carbonates); strong effervescence; moderately alkaline.

The thickness of the solum, the depth to sand and gravel, and the depth to free carbonates range from 32 to 40 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches. The content of clay in the solum ranges from 22 to 32 percent. The solum is slightly acid or neutral.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon also is loam or clay loam. It has hue of 10YR or 2.5Y and value of 4 or 5. The 2C horizon is gravelly coarse sand, sand, or loamy sand in which the content of gravel varies.

Dickinson Series

The Dickinson series consists of somewhat excessively drained soils on convex slopes in the uplands and on stream terraces. These soils formed in alluvial deposits that have been reworked by wind. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. The native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Dickinson soils are similar to Hanlon and Zenor soils and are commonly adjacent to Clarion soils. Hanlon soils have a mollic epipedon that is thicker than that of the Dickinson soils. Zenor soils contain gravel in the solum. Clarion soils have less sand and more clay in the solum than the Dickinson soils. They are on upland side slopes.

Typical pedon of Dickinson sandy loam, 5 to 9 percent slopes; 1,280 feet north and 800 feet east of the center of sec. 19, T. 89 N., R. 25 W.

Ap 0 to 6 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; very friable; neutral; clear smooth boundary.
A 6 to 11 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry;

discontinuous black (10YR 2/1) coatings on faces of peds; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.
Bw1 11 to 17 inches; brown (10YR 4/3) sandy loam; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.
Bw2 17 to 25 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure; very friable; medium acid; gradual smooth boundary.
Bw3 25 to 34 inches; yellowish brown (10YR 5/4) sandy loam; weak medium subangular blocky structure; very friable; medium acid; diffuse smooth boundary.
BC 34 to 49 inches; yellowish brown (10YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; neutral; diffuse smooth boundary.
C 49 to 60 inches; yellowish brown (10YR 5/4) loamy sand; single grained; very friable; few pebbles; neutral.

The solum ranges from 24 to 50 inches in thickness. It is medium acid to neutral. The depth to loamy sand or sand ranges from 20 to 42 inches. The depth to free carbonates is more than 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is fine sandy loam or sandy loam. The Bw horizon also is fine sandy loam or sandy loam. It typically has a higher content of sand in the lower part than in the upper part. It has value of 4 or 5 and chroma of 3 to 6. The C horizon also has value of 4 or 5 and chroma of 3 to 6. It ranges from loamy fine sand to sand.

Hanlon Series

The Hanlon series consists of moderately well drained, moderately rapidly permeable soils on bottom land. These soils formed in alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Hanlon soils are similar to Dickinson soils and are commonly adjacent to Coland, Spillville, and Turlin soils. Dickinson soils have a mollic epipedon that is thinner than that of the Hanlon soils. Coland, Spillville, and Turlin soils contain more clay and less sand in the solum than the Hanlon soils. They are in positions on bottom land similar to those of the Hanlon soils. Coland soils are poorly drained, and Spillville and Turlin soils are somewhat poorly drained.

Typical pedon of Hanlon fine sandy loam, 0 to 2 percent slopes; 1,460 feet west and 350 feet south of the northeast corner of sec. 7, T. 88 N., R. 25 W.

Ap 0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky and weak fine granular structure; very friable; neutral; abrupt smooth boundary.
A1 8 to 30 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.
A2 30 to 41 inches; black (10YR 2/1) fine sandy loam, 90 percent very dark gray (10YR 3/1) and 10 percent very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.
A3 41 to 55 inches; very dark brown (10YR 2/2) fine sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.
Bw 55 to 60 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine subangular blocky structure; very friable; neutral.

The solum ranges from 40 to 72 inches in thickness. It is slightly acid or neutral. The depth to free carbonates is more than 48 inches. The thickness of the mollic epipedon ranges from 40 to 60 inches. The content of clay in the 10- to 40-inch control section ranges from 12 to 18 percent and the content of sand from 52 to 75 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam or sandy loam. The Bw horizon also is fine sandy loam or sandy loam. It has value of 3 or 4 and chroma of 1 or 2.

Harps Series

The Harps series consists of poorly drained, moderately permeable, calcareous soils on uplands. These soils are on the rims around depressions and on flats. They formed in glacial till sediments. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Harps soils are commonly adjacent to Brownton, Canisteo, Okoboji, and Webster soils. Brownton and Canisteo soils do not have a calcic horizon and are in wide swales. Okoboji soils are very poorly drained and are in depressions. Webster soils have a noncalcareous solum and are in drainageways.

Typical pedon of Harps clay loam, 0 to 2 percent slopes; 2,450 feet north and 250 feet east of the southwest corner of sec. 4, T. 89 N., R. 25 W.

Ap 0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; violent effervescence; moderately alkaline; abrupt smooth boundary.
Ak1 8 to 17 inches; black (10YR 2/1) clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.
Ak2 17 to 23 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to weak fine granular;

friable; violent effervescence; moderately alkaline; clear smooth boundary.
Bgk1 23 to 30 inches; light olive gray (5Y 6/2) clay loam; continuous very dark gray (5Y 3/1) coatings on peds; weak fine subangular blocky structure; friable; few soft accumulations (calcium carbonates); violent effervescence; moderately alkaline; clear smooth boundary.
Bgk2 30 to 40 inches; light olive gray (5Y 6/2) loam; weak medium prismatic structure; friable; few soft accumulations (calcium carbonates); few dark concretions (manganese oxides); violent effervescence; mildly alkaline; clear smooth boundary.
Cg1 40 to 47 inches; olive gray (5Y 5/2) loam; few fine faint yellowish brown (10YR 5/8) mottles; massive; friable; few soft accumulations (calcium carbonates); few dark concretions (manganese oxides); strong effervescence; mildly alkaline; clear smooth boundary.
Cg2 47 to 53 inches; olive gray (5Y 5/2) loam; few fine prominent strong brown (7.5YR 5/8) mottles; massive; friable; few soft accumulations (calcium carbonates); few dark concretions (manganese oxides); strong effervescence; mildly alkaline; clear smooth boundary.
Cg3 53 to 60 inches; olive (5Y 5/3) loam; many coarse prominent strong brown (7.5YR 5/8) mottles; massive; friable; few soft accumulations (calcium carbonates); few dark concretions (manganese oxides); strong effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 54 inches. The mollic epipedon is from 10 to 24 inches thick. The content of clay in the 10- to 40-inch control section ranges from 22 to 32 percent. The calcium carbonate equivalent ranges from 15 to 40 percent.

The Ak horizon has value of 2 or 3. It is clay loam or loam. The Bgk horizon also is clay loam or loam. It has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 3. It is loam or sandy clay loam.

Hayden Series

The Hayden series consists of well drained, moderately permeable soils on ridges and convex side slopes in the uplands. These soils formed in glacial till. The native vegetation was deciduous trees. Slopes range from 2 to 50 percent.

Hayden soils are similar to Lester soils and are commonly adjacent to Luther and Storden soils. Lester soils have an A horizon that is thicker and darker than that of the Hayden soils. Luther soils are somewhat poorly drained, are nearly level, and are on till plains. Storden soils are calcareous and are on the steeper side slopes.

Typical pedon of Hayden loam, 2 to 5 percent slopes; 1,000 feet east and 1,100 feet south of the northwest corner of sec. 1, T. 89 N., R. 26 W.

A 0 to 4 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
E 4 to 11 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
BE 11 to 15 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.
Bt1 15 to 23 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; discontinuous thin clay films on faces of peds; medium acid; gradual smooth boundary.
Bt2 23 to 33 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine prismatic structure; firm; discontinuous thin clay films on faces of peds; medium acid; gradual smooth boundary.
BC 33 to 46 inches; light olive brown (2.5Y 5/4) clay loam; weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.
C 46 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 54 inches. The content of clay in the argillic horizon ranges from 25 to 35 percent and the content of sand from 30 to 45 percent. The solum is strongly acid to neutral.

The A horizon has value of 2 to 4 and chroma of 1 or 2. It is loam or silt loam. The E horizon also is loam or silt loam. It has value of 4 or 5 and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 5. It is clay loam or loam. The C horizon also is clay loam or loam. It has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 6.

Knoke Series

The Knoke series consists of very poorly drained, moderately slowly permeable, calcareous soils in depressions on uplands. These soils formed in glacial sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Knoke soils are similar to Okoboji soils and are commonly adjacent to Brownton, Canisteo, and Harps soils. Okoboji soils have a noncalcareous solum. Brownton soils are poorly drained and are in wide swales. Canisteo and Harps soils have less clay and more sand than the Knoke soils. They are poorly drained. Canisteo soils are in wide swales, and Harps soils are on the rims of depressions.

Typical pedon of Knoke silty clay loam, 0 to 1 percent slopes; 1,120 feet south and 1,780 feet east of the northwest corner of sec. 9, T. 87 N., R. 25 W.

Ap 0 to 8 inches; black (N 2/0) silty clay loam (38 percent clay), black (10YR 2/1) dry; weak fine subangular blocky structure; friable; slight effervescence; moderately alkaline; gradual smooth boundary.
A1 8 to 15 inches; black (N 2/0) silty clay loam (38 percent clay), black (10YR 2/1) dry; weak medium subangular blocky structure; friable; slight effervescence; moderately alkaline; gradual smooth boundary.
A2 15 to 24 inches; black (5Y 2/1) clay loam (38 percent clay), very dark gray (5Y 3/1) dry; weak medium subangular blocky structure; firm; few snail shells; many soft accumulations (calcium carbonates); slight effervescence; moderately alkaline; gradual smooth boundary.
A3 24 to 32 inches; very dark gray (5Y 3/1) clay loam (38 percent clay), dark gray (5Y 4/1) dry; weak medium subangular blocky structure; firm; few snail shells; many soft accumulations (calcium carbonates); slight effervescence; moderately alkaline; gradual smooth boundary.
Bg 32 to 44 inches; dark gray (5Y 4/1) clay loam (33 percent clay); few fine distinct olive (5Y 5/4) mottles; weak medium subangular blocky structure; friable; many soft accumulations (calcium carbonates); strong effervescence; moderately alkaline; gradual smooth boundary.
Cg 44 to 60 inches; gray (5Y 5/1) silty clay loam (29 percent clay); common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; moderately alkaline.

The solum ranges from 30 to 60 inches in thickness. It is mildly alkaline or moderately alkaline. The thickness of the mollic epipedon ranges from 24 to 36 inches. The content of clay in the 10- to 40-inch control section ranges from 35 to 40 percent.

The A horizon is neutral in hue or has hue of 2.5Y or 5Y. It has value of 2 or 3 and chroma of 1 or less. The upper part of this horizon is silty clay loam, mucky silt loam, or mucky silty clay loam. The lower part is silty clay loam, clay loam, or silty clay. The Bg horizon is neutral in hue or has hue of 2.5Y or 5Y. It has value of 4 or 5 and chroma of 2 or less. It is silty clay loam, clay loam, or silty clay. The Cg horizon ranges from loam to silty clay loam.

Kossuth Series

The Kossuth series consists of poorly drained soils on uplands. These soils are on flats, in irregularly shaped swales, and in narrow drainageways. They formed in glacial or lacustrine sediments and in the underlying glacial till. Permeability is moderately slow in the solum and moderate in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Kossuth soils are similar to Webster soils and are commonly adjacent to Bode, Brownton, and Ottosen soils. Webster soils have more sand and less clay in the solum than the Kossuth soils. Bode soils are well drained and are on ridges and convex side slopes. Brownton soils have a calcareous solum and are in wide swales. Ottosen soils are somewhat poorly drained and are on low rises.

Typical pedon of Kossuth silty clay loam, 0 to 2 percent slopes; 1,050 feet west and 80 feet north of the southeast corner of sec. 7, T. 86 N., R. 24 W.

Ap 0 to 8 inches; black (N 2/0) silty clay loam (38 percent clay), black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
A1 8 to 13 inches; black (N 2/0) silty clay loam (38 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A2 13 to 18 inches; black (5Y 2/1) silty clay loam (38 percent clay), very dark gray (5Y 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bg1 18 to 24 inches; olive gray (5Y 4/2) silty clay loam (38 percent clay); discontinuous very dark gray (5Y 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg2 24 to 30 inches; olive gray (5Y 5/2) silty clay loam (33 percent clay); discontinuous dark gray (5Y 4/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
2BCg 30 to 38 inches; olive gray (5Y 5/2) clay loam (33 percent clay); few fine prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.
2Cg 38 to 60 inches; olive gray (5Y 5/2) loam (25 percent clay); common medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 26 to 48 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The content of clay ranges from 36 to 42 percent in the A horizon and from 32 to 35 percent in the 10- to 40-inch control section. The solum is slightly acid to mildly alkaline.

The A horizon is neutral in hue or has hue of 10YR or 5Y. It has value of 2 or 3 and chroma of 1 or less. It is silty clay loam or silty clay. The Bg horizon has hue of

2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The 2Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is clay loam or loam.

Lester Series

The Lester series consists of well drained, moderately permeable soils on ridges and convex side slopes in the uplands. These soils formed in glacial till. The native vegetation was mixed prairie grasses and deciduous trees. Slopes range from 2 to 9 percent.

Lester soils are similar to Hayden soils and are commonly adjacent to Clarion, Hayden, and Luther soils. Hayden soils have an A horizon that is thinner than that of the Lester soils and have a prominent E horizon. Clarion soils have an A horizon that is thicker and darker than that of the Lester soils. Clarion and Hayden soils are in positions on side slopes and ridgetops similar to those of the Lester soils. Luther soils are somewhat poorly drained and are on nearly level slopes.

Typical pedon of Lester loam, 2 to 5 percent slopes; 2,500 feet north and 300 feet east of the southwest corner of sec. 20, T. 89 N., R. 25 W.

Ap 0 to 9 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

BE 9 to 16 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; discontinuous pale brown (10YR 6/3) silt coatings on faces of peds; slightly acid; clear smooth boundary.

Bt1 16 to 28 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; firm; continuous moderately thick dark brown (10YR 3/3) clay films on faces of peds; few shale fragments; medium acid; clear smooth boundary.

Bt2 28 to 40 inches; yellowish brown (10YR 5/4) clay loam; moderate fine subangular blocky structure; firm; discontinuous moderately thick dark brown (10YR 3/3) clay films on faces of peds; few dark concretions (iron oxides); common shale fragments; medium acid; clear smooth boundary.

BC 40 to 47 inches; light olive brown (2.5Y 5/4) clay loam; few fine faint grayish brown (10YR 5/2) and few fine distinct brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; friable; discontinuous thin clay films in root pores; common shale fragments; few dark concretions (manganese oxides); slightly acid; abrupt smooth boundary.

C1 47 to 56 inches; light olive brown (2.5Y 5/4) loam; few fine faint grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; common shale fragments; few dark concretions (manganese oxides); slight effervescence; mildly alkaline; clear smooth boundary.

C2 56 to 60 inches; mottled light olive brown (2.5Y 5/4), light brownish gray (10YR 6/2), and yellowish brown (10YR 5/6) loam; massive; friable; common shale fragments; few dark concretions (manganese oxides); slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches. The content of clay in the 10- to 40-inch control section ranges from 26 to 35 percent. The B to A clay ratio ranges from 1.2 to 1.4. The solum is medium acid to neutral.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The E horizon, if it occurs, has value of 3 or 4 and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is clay loam or loam. The C horizon also is clay loam or loam. It has value of 4 to 6 and chroma of 3 to 6.

Luther Series

The Luther series consists of somewhat poorly drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. The native vegetation was deciduous trees. Slopes range from 0 to 2 percent.

Luther soils are commonly adjacent to the well drained Hayden soils on the more sloping convex side slopes.

Typical pedon of Luther loam, 0 to 2 percent slopes; 2,400 feet north and 700 feet east of the southwest corner of sec. 16, T. 87 N., R. 26 W.

Ap 0 to 7 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

E 7 to 11 inches; grayish brown (10YR 5/2) silt loam, gray (10YR 6/1) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bt1 11 to 19 inches; dark grayish brown (10YR 4/2) clay loam; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bt2 19 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; firm; continuous thick very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt3 24 to 33 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; firm; discontinuous moderately thick dark grayish brown (2.5Y 4/2) clay films on faces of peds; few dark concretions (manganese oxides); medium acid; gradual smooth boundary.

Bt4 33 to 40 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct strong brown (7.5YR 4/6) and common medium distinct olive gray (5Y 5/2) mottles; weak medium subangular blocky structure; friable; thin discontinuous clay flows in root channels; few dark concretions (manganese oxides); slightly acid; gradual smooth boundary.
BC 40 to 48 inches; grayish brown (2.5Y 5/2) clay loam; common fine distinct olive gray (5Y 5/2) and common fine distinct brownish yellow (10YR 6/8) mottles; weak medium subangular blocky structure; friable; few dark concretions (manganese oxides); neutral; gradual wavy boundary.
C 48 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; many dark concretions (manganese oxides); slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 36 to 60 inches. The content of clay in the 10- to 40-inch control section ranges from 24 to 35 percent. The solum is strongly acid to slightly acid.

The A and E horizons have value of 4 or 5 and chroma of 1 or 2. They are loam or silt loam. The B horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 or 3.

Nicollet Series

The Nicollet series consists of somewhat poorly drained, moderately permeable soils on low rises and slightly concave side slopes in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Nicollet soils are similar to Ottosen soils and are commonly adjacent to Canisteo, Clarion, and Webster soils. Ottosen soils have more clay and less sand in the solum than the Nicollet soils. Canisteo and Webster soils are poorly drained and are in wide swales and drainageways. Clarion soils are well drained and are on ridges and convex side slopes.

Typical pedon of Nicollet loam, 1 to 3 percent slopes; 1,920 feet north and 90 feet east of the southwest corner of sec. 22, T. 89 N., R. 23 W.

Ap 0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium granular structure; friable; slightly acid; gradual smooth boundary.
A1 8 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium granular structure; friable; slightly acid; gradual smooth boundary.
A2 13 to 18 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
Bw 18 to 28 inches; dark grayish brown (10YR 4/2) loam; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
BC 28 to 36 inches; dark grayish brown (10YR 4/2) and brown (10YR 5/3) loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.
C1 36 to 48 inches; light olive brown (2.5Y 5/4) loam; few fine faint olive yellow (2.5Y 6/8) and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline; gradual smooth boundary.
C2 48 to 60 inches; grayish brown (2.5Y 5/2) loam; few fine faint olive brown (2.5Y 4/4) and few fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. The content of clay in the 10- to 40-inch control section ranges from 24 to 30 percent. The solum is medium acid to mildly alkaline.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon also is loam or clay loam. It has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4.

Okoboji Series

The Okoboji series consists of very poorly drained, moderately slowly permeable soils in depressions on uplands. These soils formed in glacial sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Okoboji soils are similar to Knoke soils and are commonly adjacent to Canisteo, Harps, and Webster soils. Knoke, Canisteo, and Harps soils have a calcareous solum. Canisteo, Harps, and Webster soils are poorly drained. They contain more sand and less clay in the solum than the Okoboji soils. Canisteo and Webster soils are in wide swales and drainageways, and Harps soils are on the rims of depressions.

Typical pedon of Okoboji silty clay loam, 0 to 1 percent slopes; 1,800 feet west and 2,150 feet south of the northeast corner of sec. 4, T. 89 N., R. 25 W.

Ap 0 to 8 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
A1 8 to 16 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2 16 to 28 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bg 28 to 36 inches; olive gray (5Y 4/2) and very dark gray (5Y 3/1) silty clay loam; common medium prominent light olive brown (2.5Y 5/6) mottles; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
BCg 36 to 42 inches; olive gray (5Y 4/2 and 5/2) clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.
Cg 42 to 60 inches; olive gray (5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; slight effervescence; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. It is slightly acid to moderately alkaline. The depth to free carbonates ranges from 30 to 50 inches. The thickness of the mollic epipedon ranges from 24 to 36 inches. The content of clay in the 10- to 40-inch control section is 35 to 40 percent.

The A horizon is neutral in hue or has hue of 10YR. It has chroma of 1 or less. It is silty clay loam, mucky silty clay loam, silt loam, or mucky silt loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam or silty clay. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It ranges from silty clay loam to loam.

Ottosen Series

The Ottosen series consists of somewhat poorly drained soils on low rises and slightly concave side slopes in the uplands. These soils formed in glacial or lacustrine sediments and in the underlying glacial till. Permeability is moderately slow in the upper part of the profile and moderate in the lower part. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Ottosen soils are similar to Nicollet soils and are commonly adjacent to Bode, Brownton, and Kossuth soils. Nicollet soils have less clay and more sand in the solum than the Ottosen soils. Bode soils are well drained and are on convex side slopes and on ridges. Brownton and Kossuth soils are poorly drained and are in wide swales and drainageways.

Typical pedon of Ottosen clay loam, 1 to 3 percent slopes; 880 feet east and 150 feet south of the northwest corner of sec. 18, T. 86 N., R. 24 W.

Ap 0 to 9 inches; black (10YR 2/1) clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
A 9 to 15 inches; black (10YR 2/1) clay loam (33 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bw1 15 to 23 inches; dark grayish brown (2.5Y 4/2) clay loam (38 percent clay); discontinuous very dark brown (10YR 2/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bw2 23 to 32 inches; dark grayish brown (2.5Y 4/2) clay loam (38 percent clay); common medium faint light olive brown (2.5Y 5/6) mottles; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
C1 32 to 40 inches; light olive brown (2.5Y 5/4) clay loam (29 percent clay); few fine faint yellowish brown (10YR 5/4) and gray (5Y 6/1) mottles; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.
2C2 40 to 60 inches; light olive brown (2.5Y 5/4) loam (24 percent clay); common medium prominent yellowish brown (10YR 5/4), common medium distinct gray (5Y 6/1), and few fine prominent yellowish brown (10YR 5/6) mottles; massive; firm; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches. The content of clay in the 10- to 40-inch control section is 30 to 35 percent. The solum is medium acid to neutral.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 1 or 2. It is clay loam or silty clay loam. The Bw horizon also is clay loam or silty clay loam. It has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The 2C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4.

Palms Series

The Palms series consists of very poorly drained soils in upland basins that were formerly lakes or ponds. These soils formed in highly decomposed organic material and in the underlying lacustrine sediments. Permeability is moderately rapid in the organic material and moderate in the underlying sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Palms soils are commonly adjacent to Canisteo, Harps, and Wacousta soils. None of these soils formed in organic material. Canisteo soils are poorly drained and are in broad swales. Harps soils have a calcareous solum and are on the rims of depressions. Wacousta soils have a solum that is thinner than that of the Palms soils. They are in positions in the upland basins similar to those of the Palms soils.

Typical pedon of Palms muck, 0 to 1 percent slopes; 2,500 feet east and 1,100 feet north of the southwest corner of sec. 10, T. 88 N., R. 23 W.

Op 0 to 7 inches; sapric material, black (N 2/0) broken face and rubbed, black (10YR 2/1) dry; less than 5 percent fiber; weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.
Oa1 7 to 14 inches; sapric material, black (N 2/0) broken face and rubbed, very dark gray (10YR 3/1) dry; less than 5 percent fiber; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.
Oa2 14 to 21 inches; sapric material, black (10YR 2/1) broken face and rubbed, dark gray (10YR 4/1) dry; less than 10 percent fiber; weak fine subangular blocky structure; very friable; common snail shells; strong effervescence; mildly alkaline; clear smooth boundary.
Oa3 21 to 26 inches; sapric material, black (N 2/0) broken face and rubbed, gray (10YR 5/1) dry; less than 10 percent fiber; weak medium subangular blocky structure; very friable; common snail shells; strong effervescence; mildly alkaline; clear smooth boundary.
Oa4 26 to 38 inches; sapric material, black (10YR 2/1) broken face and rubbed, gray (10YR 5/1) dry; less than 5 percent fiber; weak medium subangular blocky structure; friable; common snail shells; slight effervescence; mildly alkaline; gradual smooth boundary.
Oa5 38 to 46 inches; sapric material, black (10YR 2/1) broken face and rubbed, dark gray (10YR 4/1) dry; less than 5 percent fiber; weak fine subangular blocky structure; friable; common snail shells; slight effervescence; mildly alkaline; abrupt smooth boundary.
C 46 to 60 inches; very dark grayish brown (2.5Y 3/2) silty clay loam; few fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; slight effervescence; moderately alkaline.

The thickness of the sapric material ranges from 16 to 50 inches. The depth to free carbonates ranges from 12 to 40 inches. The solum is slightly acid to moderately alkaline.

The Oa horizon is neutral in hue or has hue of 10YR. It has chroma of 2 or less. It has thin layers of hemic material in some pedons. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 7, and chroma of 1 or 2. It ranges from silty clay loam to sandy loam.

Spillville Series

The Spillville series consists of somewhat poorly drained, moderately permeable soils on bottom land. These soils formed in alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Spillville soils are similar to Terril and Turlin soils and are commonly adjacent to Coland and Hanlon soils. Terril and Turlin soils have a mollic epipedon that is thinner than that of the Spillville soils. Coland soils have more clay and less sand in the solum than the Spillville soils. They are poorly drained. Hanlon soils have more sand and less clay in the solum than the Spillville soils. They are moderately well drained. Coland and Hanlon soils are in positions on bottom land similar to those of the Spillville soils.

Typical pedon of Spillville loam, 0 to 2 percent slopes; 1,180 feet east and 300 feet north of the southwest corner of sec. 8, T. 89 N., R. 25 W.

Ap 0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A1 8 to 14 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A2 14 to 23 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A3 23 to 36 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A4 36 to 52 inches; very dark grayish brown (10YR 3/2) loam; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.
C 52 to 60 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; mildly alkaline.

The solum ranges from 36 to 56 inches in thickness. It is medium acid to neutral. The depth to free carbonates is 48 inches or more. The thickness of the mollic epipedon ranges from 30 to 56 inches. The content of clay in the 10- to 40-inch control section ranges from 18 to 26 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Below a depth of 36 inches, it ranges from sandy loam to clay loam. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2. It is loam or sandy loam.

Storden Series

The Storden series consists of well drained, moderately permeable, calcareous soils on knobs and convex side slopes in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 5 to 50 percent.

Storden soils are commonly adjacent to the noncalcareous Clarion, Hayden, and Zenor soils. The adjacent soils are in positions on upland ridgetops and

side slopes similar to those of the Storden soils. Clarion soils have an A horizon that is thicker and darker than that of the Storden soils. Hayden soils have an argillic horizon. Zenor soils have more sand and less clay in the solum than the Storden soils.

Typical pedon of Storden loam, 5 to 9 percent slopes, moderately eroded; 200 feet north and 200 feet east of the southwest corner of sec. 13, T. 86 N., R. 23 W.

Ap 0 to 6 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; mixed with some streaks and pockets of yellowish brown (10YR 5/4) substratum material; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1 6 to 40 inches; yellowish brown (10YR 5/4) loam; weak fine subangular blocky structure; friable; few soft accumulations (calcium carbonates); strong effervescence; moderately alkaline; gradual smooth boundary.

C2 40 to 52 inches; light olive brown (2.5Y 5/4) loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (manganese oxides); strong effervescence; moderately alkaline; gradual smooth boundary.

C3 52 to 60 inches; light olive brown (2.5Y 5/4) loam; few medium prominent strong brown (7.5YR 5/8) and common fine faint yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (manganese oxides); strong effervescence; moderately alkaline.

The thickness of the solum is the same as the thickness of the A horizon. Free carbonates are in all horizons. The content of clay in the 10- to 40-inch control section ranges from 18 to 27 percent. The solum is mildly alkaline or moderately alkaline.

The A horizon has value of 4 or 5 and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 6.

Talcot Series

The Talcot series consists of poorly drained, calcareous soils in concave areas on stream terraces. These soils formed in alluvium underlain by sand and gravel. Permeability is moderate in the solum and rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Talcot soils are similar to Biscay soils and are commonly adjacent to Biscay and Cylinder soils. Biscay and Cylinder soils have a noncalcareous solum. Biscay soils are in positions on the stream terraces similar to those of the Talcot soils. Cylinder soils are somewhat poorly drained and are in slightly convex areas on the stream terraces.

Typical pedon of Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 150 feet east and 1,400 feet north of the southwest corner of sec. 24, T. 86 N., R. 25 W.

Ap 0 to 8 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine granular structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

A1 8 to 17 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A2 17 to 22 inches; black (N 2/0) clay loam; continuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bg1 22 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bg2 30 to 38 inches; olive gray (5Y 5/2) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; about 5 percent gravel; few soft accumulations (calcium carbonates); slight effervescence; mildly alkaline; clear smooth boundary.

2Cg 38 to 60 inches; olive gray (5Y 5/2) gravelly loamy coarse sand; single grained; loose; about 20 percent gravel; few soft accumulations (calcium carbonates); strong effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 32 to 40 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The content of clay in the solum ranges from 27 to 35 percent. The solum is mildly alkaline or moderately alkaline.

The A horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 1 or less. It is silty clay loam or clay loam. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It ranges from sandy clay loam to silty clay loam. The Cg horizon is gravelly loamy sand, loamy sand, or sand in which the content of gravel varies.

Terril Series

The Terril series consists of moderately well drained, moderately permeable soils on upland foot slopes. These soils formed in local alluvium. The native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Terril soils are similar to Spillville and Turlin soils and are commonly adjacent to Clarion, Coland, and Storden soils. Spillville soils have an A horizon that is thicker than that of the Terril soils. Spillville and Turlin soils are somewhat poorly drained. Clarion and Storden soils have an A horizon that is thinner and lighter colored than that of the Terril soils. They are on ridges and convex side slopes in the uplands. Coland soils are poorly drained and are on bottom land.

Typical pedon of Terril loam, 2 to 5 percent slopes; 850 feet north and 700 feet east of the center of sec. 12, T. 89 N., R. 26 W.

Ap 0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak medium granular; friable; neutral; clear smooth boundary.
A1 7 to 17 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.
A2 17 to 25 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
A3 25 to 32 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bw1 32 to 41 inches; brown (10YR 4/3) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bw2 41 to 47 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
BC 47 to 60 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; neutral.

The solum ranges from 36 to 72 inches in thickness. It is slightly acid or neutral. The thickness of the mollic epipedon ranges from 24 to 36 inches. The content of clay in the 10- to 40-inch control section ranges from 18 to 30 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon also is loam or clay loam. It has value and chroma of 3 or 4.

Turlin Series

The Turlin series consists of somewhat poorly drained, moderately permeable soils on bottom land and alluvial fans. These soils formed in alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Turlin soils are similar to Spillville and Terril soils and are commonly adjacent to Hanlon soils. Spillville soils have an A horizon that is thicker than that of the Turlin soils. Terril soils are moderately well drained. Hanlon soils contain more sand and less clay in the solum than the Turlin soils. They are in positions on bottom land similar to those of the Turlin soils.

Typical pedon of Turlin loam, 0 to 2 percent slopes; 2,210 feet south and 2,080 feet west of the northeast corner of sec. 20, T. 87 N., R. 26 W.

Ap 0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
A1 7 to 26 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.
A2 26 to 34 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.
Bw 34 to 45 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; neutral; gradual wavy boundary.
C 45 to 60 inches; dark grayish brown (10YR 4/2) loam; massive; friable; mildly alkaline.

The solum ranges from 40 to 70 inches in thickness. It is slightly acid or neutral. The thickness of the mollic epipedon ranges from 24 to 36 inches. The content of clay in the 10- to 40-inch control section ranges from 18 to 27 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. The B horizon also is loam or silt loam. It has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. The lower part of the B horizon and the C horizon have strata of sandy loam or loamy sand in some pedons.

Wacousta Series

The Wacousta series consists of very poorly drained, moderately permeable soils in upland basins and depressions. These soils formed in lacustrine sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Wacousta soils are similar to Calcousta soils and are commonly adjacent to Canisteo, Harps, and Palms soils. Calcousta soils have a calcareous solum. Canisteo and Harps soils also have a calcareous solum. They contain more sand and less silt in the solum than the Wacousta soils. They are poorly drained. Canisteo soils are in broad swales, and Harps soils are on the rims of depressions. Palms soils formed in sapric material and in the underlying lacustrine sediments. They are in

positions in upland basins similar to those of the Wacousta soils.

Typical pedon of Wacousta silty clay loam, 0 to 1 percent slopes; 800 feet north and 90 feet west of the southeast corner of sec. 9, T. 89 N., R. 26 W.

Ap 0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A 7 to 11 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

Bg 11 to 18 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; very dark gray (10YR 3/1) organic coatings along root channels; mildly alkaline; abrupt wavy boundary.

Cg1 18 to 22 inches; olive gray (5Y 5/2) silty clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; very dark gray (10YR 3/1) organic coatings along root channels; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg2 22 to 30 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct dark brown (7.5YR 4/4) and common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; dark gray (10YR 4/1) organic coatings along root channels; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg3 30 to 48 inches; mottled light olive gray (5Y 6/2), strong brown (7.5YR 5/6), and dark brown (7.5YR 4/4) silty clay loam; massive; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg4 48 to 60 inches; light olive gray (5Y 6/2) silt loam; few medium faint olive yellow (2.5Y 6/6) and common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 12 to 24 inches. The thickness of the mollic epipedon ranges from 8 to 18 inches. The content of clay in the 10- to 40-inch control section ranges from 24 to 35 percent. The solum is slightly acid to moderately alkaline.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 and chroma of 1 or less. It is silty clay loam, silt loam, or mucky silt loam. The Bg horizon has value of 4 to 6 and chroma of 1 or 2. It is silty clay loam or silt loam. The Cg horizon has value of 5 or 6 and chroma of 1 or 2. It is clay loam, silty clay loam, or silt loam.

Wadena Series

The Wadena series consists of well drained soils in convex areas on stream terraces. These soils formed in alluvium underlain by sand and gravel at a depth of 24 to 40 inches. Permeability is moderate in the upper part of the profile and very rapid in the lower part. The native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Wadena soils are similar to Cylinder soils and are commonly adjacent to Biscay and Cylinder soils. Cylinder soils are somewhat poorly drained and are at the lower elevations on the stream terraces. Biscay soils are poorly drained and are in concave areas on the stream terraces.

Typical pedon of Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 2,200 feet south and 100 feet east of the northwest corner of sec. 7, T. 89 N., R. 25 W.

Ap 0 to 7 inches; black (10YR 2/1) loam, very dark brown (10YR 2/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A1 7 to 12 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A2 12 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw1 17 to 28 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

2Bw2 28 to 34 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; about 10 percent gravel; neutral; clear smooth boundary.

2C 34 to 60 inches; grayish brown (10YR 5/2) gravelly sand; single grained; loose; about 25 percent gravel; few soft accumulations (calcium carbonates); slight effervescence; mildly alkaline.

The thickness of the solum, the depth to sand and gravel, and the depth to free carbonates range from 24 to 40 inches. The thickness of the mollic epipedon ranges from 12 to 20 inches. The content of clay in the solum ranges from 18 to 30 percent. The solum is slightly acid or neutral.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam or clay loam in the upper part and sandy loam, sandy clay loam, or loam in the lower part. The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is loamy sand, sand, or gravelly sand

in which the content of gravel varies. This horizon is commonly stratified.

Webster Series

The Webster series consists of poorly drained, moderately permeable soils on uplands. These soils are on flats, in swales, and in low gradient drainageways. They formed in glacial sediments. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Webster soils are similar to Kossuth soils and are commonly adjacent to Canisteo, Clarion, and Nicollet soils. Kossuth soils have more clay and less sand in the solum than the Webster soils. Canisteo soils have a calcareous solum and are in wide swales. Clarion soils are well drained and are on ridges and convex side slopes. Nicollet soils are somewhat poorly drained and are on low rises.

Typical pedon of Webster silty clay loam, 0 to 2 percent slopes; 700 feet west and 1,480 feet north of the southeast corner of sec. 12, T. 88 N., R. 26 W.

Ap 0 to 8 inches; black (N 2/0) silty clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A 8 to 16 inches; black (N 2/0) silty clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

BA 16 to 21 inches; dark gray (5Y 4/1) silty clay loam (33 percent clay); few fine distinct grayish brown (2.5Y 5/2) mottles; continuous very dark gray (5Y 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bg1 21 to 26 inches; olive gray (5Y 5/2) silty clay loam (33 percent clay); continuous very dark gray (5Y 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg2 26 to 32 inches; light olive gray (5Y 6/2) clay loam (33 percent clay); discontinuous very dark gray (5Y 3/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

BCg 32 to 40 inches; light olive gray (5Y 6/2) clay loam (29 percent clay); few fine distinct yellowish brown (10YR 5/4) and few fine prominent yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; few soft accumulations (calcium carbonates); mildly alkaline; clear smooth boundary.

Cg 40 to 60 inches; light olive gray (5Y 6/2) loam (24 percent clay); common medium distinct yellowish brown (10YR 5/4) and common medium prominent yellowish brown (10YR 5/8) mottles; massive; friable; few soft accumulations (calcium carbonates); strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 42 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The content of clay in the 10- to 40-inch control section is 28 to 35 percent. The solum is neutral or mildly alkaline.

The A horizon is neutral in hue or has hue of 10YR. It has chroma of 1 or less. It is silty clay loam or clay loam. The Bg horizon also is silty clay loam or clay loam. It has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 5Y or 2.5Y, value of 5 or 6, and chroma of 2 or 3. It is loam or clay loam.

Zenor Series

The Zenor series consists of somewhat excessively drained soils on knobs and convex side slopes in the uplands. These soils formed in glacial outwash. Permeability is moderately rapid in the solum and rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 2 to 18 percent.

Zenor soils are similar to Dickinson soils and are commonly adjacent to Clarion and Storden soils. Dickinson soils do not have gravel in the solum and are leached to a depth of 60 inches. Clarion and Storden soils contain more clay and less sand in the solum than the Zenor soils. They are in positions on upland ridges and side slopes similar to those of the Zenor soils.

Typical pedon of Zenor sandy loam, 2 to 5 percent slopes; 750 feet east and 250 feet south of the northwest corner of sec. 10, T. 88 N., R. 24 W.

Ap 0 to 7 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

A 7 to 12 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

Bw1 12 to 20 inches; brown (10YR 4/3) sandy loam; weak medium subangular blocky structure parting to weak fine granular; very friable; about 5 percent gravel; neutral; gradual smooth boundary.

Bw2 20 to 32 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure parting to weak fine granular; very friable; about 10 percent gravel; neutral; gradual wavy boundary.

C1 32 to 48 inches; yellowish brown (10YR 5/4) loamy sand; single grained; loose; about 10 percent gravel; slight effervescence; mildly alkaline; gradual wavy boundary.

C2 48 to 60 inches; yellowish brown (10YR 5/4) gravelly loamy sand; single grained; loose; about 25 percent gravel; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 16 inches. The solum is medium acid to moderately alkaline.

The A horizon has value and chroma of 2 or 3. It is sandy loam or loam. The Bw horizon also is sandy loam or loam. It has value of 4 or 5 and chroma of 3 to 5. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 5 to 7, and chroma of 3 to 6. It is loamy sand, gravelly loamy sand, gravelly sand, or sand.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate during and after the accumulation of the soil material, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material. Human activities also affect soil formation.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plants are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Generally, a long period is needed for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

Parent Material

The accumulation of parent material is the first step in the formation of a soil. Most of the soils in the county formed in material transported from other locations and deposited through the action of glacial ice, water, wind, or gravity. The principal parent materials are glacial drift, alluvium, and lacustrine deposits.

Hamilton County was subject to three stages of glaciation the Nebraskan, the Kansan, and the Wisconsin. Many of the soils in the county formed mainly in glacial till deposited by the most recent of these, the Wisconsin Glaciation. The county is near the center of the Des Moines lobe of this glaciation. The glacial till in this lobe was deposited by the Cary substage of this glaciation (*11, 12*). Radiocarbon dates from the base of the till in the southern part of the lobe indicate that this deposition occurred about 13,000 to 14,000 years ago. The youth of the Cary substage also is indicated by a poorly developed surface drainage system and by numerous closed depressions.

Glacial drift is all rock material transported and deposited by glacial ice, including the material sorted by melt water. It includes glacial till, glacial sediments, and glacial outwash. Glacial till is unsorted sediments in which particles range in size from boulders to clay (*11*). Glacial sediments are the loamy materials that have been sorted to some extent by water. The fact that these sediments are in potholes or other low lying areas indicates that some of the sorting and deposition has occurred since the time of glaciation. Glacial outwash is the sandy and gravelly material sorted out by glacial melt water and deposited in valleys or other areas where water was concentrated.

Clarion, Lester, Nicollet, and Storden soils formed in glacial till. Canisteo, Harps, and Webster soils, which are in the lower lying areas on the landscape, formed in glacial till and in glacial sediments or reworked glacial till. Okoboji, Palms, and Wacousta soils formed in alluvial sediments derived from till that in many places washed in from nearby slopes. Zenor soils formed in loamy material that overlies glacial outwash.

Alluvium is material deposited by water along the major and minor streams and drainageways and on terraces. Coland, Hanlon, and Spillville soils formed in alluvium on bottom land that is subject to flooding. The texture of the alluvium varies widely because of differences in the material from which it came and the manner in which it was deposited. Some alluvium has been transported only a short distance and is called local alluvium. Such alluvium retains many characteristics of the soils in the areas from which it eroded. Terril soils formed in local alluvium. They generally are at the base of slopes, below the soils that formed in glacial till. Their texture is similar to that of the soils upslope.

Biscay, Cylinder, Talcot, and Wadena soils formed in loamy alluvium that is underlain by sand and gravel. They are mainly on terraces near streams, but some are in low lying upland areas. The material in which these soils formed probably was deposited by the melt water from the receding Cary glacial ice.

Lacustrine sediments probably were deposited by the still water of lakes near the margin of the glacial ice, rather than by rapidly moving melt water. They are mainly 24 to about 36 inches deep over glacial till. Bode, Brownton, Kossuth, and Ottosen soils formed in lacustrine sediments and in the underlying glacial till.

Climate

The soils in Hamilton County formed under a variety of climatic conditions. In the post-Cary glaciation period, 13,000 to 10,500 years ago, the climate was cool and the vegetation was dominantly conifers. During the period beginning about 10,500 years ago and ending about 8,000 years ago, a warming trend changed the vegetation from conifers to mixed hardwoods. Beginning about 8,000 years ago, the climate became warmer and drier and herbaceous prairie vegetation became dominant. Probably about 3,000 years ago, a change from a dry to a more moist climate began (*9*). The soils in the county formed under the influence of this subhumid midcontinental climate.

Because it is nearly uniform throughout the county, the climate has not resulted in major differences among the soils in the survey area. The effect of the climate, however, is modified by local conditions in or near the soil. On south-facing slopes, for example, the temperature is higher and the humidity lower than is typical in nearby areas and on north- and east-facing slopes. As a result, natural stands of trees are more likely to grow well on the north- and east-facing slopes. The poorly drained or very poorly drained soils in low lying areas or depressions are wetter and cooler than the soils in most of the surrounding areas.

Changes in temperature activate the weathering of parent material by water and air. As the parent material weathers, changes caused by physical and chemical actions take place. Rainfall affects the amount of leaching in the soil and the kinds of plants on the soil.

Climate indirectly affects soil formation through the effects of temperature and other climatic factors on the plant and animal life on and in the soil.

Relief

Relief is an important factor of soil formation because of its effect on drainage, runoff, depth to the water table, and erosion. Slopes range from level to very steep in Hamilton County. A difference in topography is the main reason for the differing properties of some of the soils in the county.

Slope affects the thickness and color of the A horizon and the thickness of the solum because of its effect on erosion and the amount of water that runs off the surface and percolates through the soil. For example, it has affected the thickness and color of the A horizon in Storden, Clarion, and Nicollet soils, which formed in similar parent materials. The A horizon in the moderately sloping to very steep Storden soils is thinner and lighter in color than that in the gently sloping to strongly sloping Clarion soils and the very gently sloping Nicollet soils. Likewise, Storden soils have a thinner solum and are shallower to carbonates. In soils that have a wide range of slope, such as the gently sloping to strongly sloping Clarion soils, the depth to carbonates and the thickness of the solum decrease as the percentage of slope increases.

Relief affects the color of the B horizon through its effect on drainage and soil aeration. The subsoil of a well drained soil generally is brownish because oxidized iron compounds are well distributed throughout the horizon. Clarion soils are an example. The subsoil of a poorly drained or very poorly drained, poorly aerated soil generally is grayish and mottled. The nearly level, poorly drained Webster soils and the level, very poorly drained Okoboji soils are examples. Nicollet soils are somewhat poorly drained and have a grayish brown B horizon. Their profile characteristics indicate that their drainage class is between that of a well drained soil and that of a poorly drained soil.

Plant and Animal Life

Soil formation really begins when plants are established. As the plants grow and die, they add organic matter to the upper layers of the soil. Native grasses have myriads of fibrous roots that penetrate the soil to a depth of 10 to 20 inches and add large amounts of organic matter to the surface layer. Trees commonly feed on plant nutrients deep in the subsoil. As a result, the surface layer generally accumulates only the organic matter from the decaying fallen leaves and dead trees. Much of this organic matter remains on the surface, where it decomposes.

All living organisms, including vegetation, animals, bacteria, and fungi, affect soil formation. The vegetation chiefly determines the color of the surface layer and the content of organic matter and nutrients in the soil. Earthworms and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the vegetation and thereby release plant nutrients.

Most of the soils of Hamilton County formed under prairie grasses or a mixture of prairie grasses and water-tolerant plants. Clarion and Nicollet are typical of soils that formed under prairie grasses and Webster and Canisteo of soils that formed under prairie grasses and water-tolerant plants. Soils that formed under prairie grasses contain a large amount of organic matter derived from roots and have a thick, dark surface layer. Hayden soils are typical of soils that formed under trees. They have a dark surface layer that generally is less than 5 inches thick and a lighter colored subsurface layer. If these layers are mixed by plowing, the new surface layer is lighter in color than that of prairie soils.

Lester soils have properties both of the soils that formed entirely under prairie grasses and of the soils that formed entirely under forest vegetation. They probably formed under prairie grasses and then under forest vegetation. Their properties generally are those of a true forest soil, but the surface layer is somewhat thicker.

Time

Time enables relief, climate, and plant and animal life to change the parent material. If these factors continue to operate for a long period, very similar kinds of soil form in widely different kinds of parent material. Soil formation, however, generally is interrupted by geologic events that expose new parent material. In Hamilton County new parent material was added to the uplands at least four times. The bedrock was covered by glacial drift from two glaciers, and then loess was deposited. Another glacier subsequently deposited the present surface material.

According to radiocarbon dates from its base in the southern part of the Des Moines lobe, Cary glacial drift was deposited about 14,000 years ago (*11*). Hence, all of the soils that formed in the drift are no more than 14,000 years old. In much of Iowa, including parts of Hamilton County, geologic erosion has beveled and in places removed material from side slopes and deposited new sediments downslope (*13*). The surfaces of nearly level upland divides are older than the slopes that truncate the divides. Thus, the soils on these side slopes, including Clarion and Lester soils, are less than 14,000 years old. Further dating indicates that they are less than 3,000 years old. The sediments washed from the side slopes accumulated downslope as local alluvium. Some of the alluvium at the base of the slopes is less than 3,000 years old (*13*). Coland, Spillville, Terril, and other soils formed in this alluvium.

Human Activities

Important changes take place in the soil after it is drained and cultivated. Some of these changes have little effect on soil productivity, but others have drastic effects. Changes caused by erosion generally are the most significant. On some of the cultivated soils in the county, particularly the steeper ones, much of the original surface layer has been lost through sheet erosion. Many of the soils, however, have not been affected by erosion, mainly because low relief is common in the county.

Management practices have increased the productivity of some soils and reclaimed areas that otherwise are not suitable for crops. Crops can be grown, for example, in many areas where subsurface drains have sufficiently lowered the water table. Applications of commercial fertilizer have overcome deficiencies in plant nutrients and thus have increased the productivity of many soils.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the

surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are

Loose. Noncoherent when dry or moist; does not hold together in a mass.

Friable. When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard. When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. When dry, breaks into powder or individual grains under very slight pressure.

Cemented. Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained. Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained. Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained. Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained. Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained. Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained. Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table; a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained. Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly

continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated

by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon. An organic layer of fresh and decaying plant residue.

A horizon. The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon. The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon. The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon. The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon. Soft, consolidated bedrock beneath the soil.

R layer. Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are

Border. Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin. Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding. Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation. Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle). Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow. Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler. Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation. Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding. Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance *few, common,* and *many*; size *fine, medium,* and *coarse*; and contrast *faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material).

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can

be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of

separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data were recorded in the period 1951-81 at Webster City, Iowa]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	25.4	6.5	16.0	51	-22	0	0.67	0.26	1.01	2	6.3
February---	31.8	12.6	22.2	56	-20	0	.93	.27	1.46	3	6.8
March------	42.5	23.3	32.9	76	-8	27	1.77	.82	2.58	5	6.8
April------	60.4	36.9	48.7	88	17	93	2.82	1.54	3.93	6	1.2
May--------	72.6	48.2	60.4	91	28	333	3.69	2.42	4.84	8	.0
June-------	81.1	58.0	69.6	96	41	588	4.54	2.96	5.97	8	.0
July-------	84.6	62.4	73.5	98	47	729	4.13	1.88	6.05	7	.0
August-----	82.4	59.9	71.2	96	43	657	4.16	2.08	5.97	7	.0
September--	75.0	50.5	62.8	93	30	384	2.76	1.06	4.18	6	.0
October----	64.0	39.6	51.8	89	18	152	2.09	.67	3.25	5	.1
November---	45.8	26.3	36.1	72	0	6	1.22	.31	1.94	3	2.4
December---	31.4	14.1	22.8	58	-18	0	.91	.41	1.33	3	6.4
Yearly:											
Average-	58.1	36.5	47.3	---	---	---	---	---	---	---	---
Extreme-	---	---	---	100	-25	---	---	---	---	---	---
Total---	---	---	---	---	---	2,969	29.69	23.94	34.75	63	30.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data were recorded in the period 1951-81 at Webster City, Iowa]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 20	May 4	May 18
2 years in 10 later than--	April 15	April 30	May 14
5 years in 10 later than--	April 7	April 22	May 4
First freezing temperature in fall:			
1 year in 10 earlier than--	October 9	September 30	September 19
2 years in 10 earlier than--	October 15	October 5	September 24
5 years in 10 earlier than--	October 24	October 14	October 3

TABLE 3.--GROWING SEASON

[Data were recorded in the period 1951-81 at Webster City, Iowa]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	179	155	137
8 years in 10	186	162	141
5 years in 10	199	174	151
2 years in 10	213	186	160
1 year in 10	220	193	165

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
4	Knoke silty clay loam, 0 to 1 percent slopes	680	0.2
6	Okoboji silty clay loam, 0 to 1 percent slopes	7,340	2.0
27B	Terril loam, 2 to 5 percent slopes	1,000	0.3
27C	Terril loam, 5 to 9 percent slopes	320	0.1
48	Knoke mucky silty clay loam, 0 to 1 percent slopes	630	0.2
52B	Bode clay loam, 2 to 5 percent slopes	17,760	4.8
52C	Bode clay loam, 5 to 9 percent slopes	1,200	0.3
52C2	Bode clay loam, 5 to 9 percent slopes, moderately eroded	3,580	1.0
55	Nicollet loam, 1 to 3 percent slopes	34,560	9.4
62C2	Storden loam, 5 to 9 percent slopes, moderately eroded	1,030	0.3
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded	2,010	0.5
62E2	Storden loam, 14 to 18 percent slopes, moderately eroded	980	0.3
62F	Storden loam, 18 to 25 percent slopes	330	0.1
90	Okoboji mucky silty clay loam, 0 to 1 percent slopes	2,880	0.8
95	Harps clay loam, 0 to 2 percent slopes	15,120	4.1
96	Turlin loam, 0 to 2 percent slopes	300	0.1
107	Webster silty clay loam, 0 to 2 percent slopes	27,360	7.4
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes	1,270	0.3
135	Coland clay loam, 0 to 2 percent slopes	2,460	0.7
138B	Clarion loam, 2 to 5 percent slopes	38,260	10.4
138B2	Clarion loam, 2 to 5 percent slopes, moderately eroded	1,480	0.4
138C	Clarion loam, 5 to 9 percent slopes	720	0.2
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	13,850	3.7
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	700	0.2
168B	Hayden loam, 2 to 5 percent slopes	1,850	0.5
168C	Hayden loam, 5 to 9 percent slopes	320	0.1
168C2	Hayden loam, 5 to 9 percent slopes, moderately eroded	380	0.1
168E	Hayden loam, 14 to 18 percent slopes	400	0.1
175B	Dickinson sandy loam, 2 to 5 percent slopes	280	0.1
175C	Dickinson sandy loam, 5 to 9 percent slopes	230	*
201B	Coland-Terril complex, 1 to 5 percent slopes	1,000	0.3
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,280	0.3
221	Palms muck, 0 to 1 percent slopes	2,300	0.6
236B	Lester loam, 2 to 5 percent slopes	1,270	0.3
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded	240	0.1
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	810	0.2
288	Ottosen clay loam, 1 to 3 percent slopes	30,740	8.3
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,040	0.3
355	Luther loam, 0 to 2 percent slopes	1,510	0.4
356G	Storden-Hayden loams, 25 to 50 percent slopes	4,220	1.1
388	Kossuth silty clay loam, 0 to 2 percent slopes	21,650	5.9
485	Spillville loam, 0 to 2 percent slopes	910	0.2
506	Wacousta silty clay loam, 0 to 1 percent slopes	1,080	0.3
507	Canisteo silty clay loam, 0 to 2 percent slopes	63,310	17.1
508	Calcousta silty clay loam, 0 to 1 percent slopes	790	0.2
511	Blue Earth mucky silt loam, 0 to 1 percent slopes	1,010	0.3
536	Hanlon fine sandy loam, 0 to 2 percent slopes	1,020	0.3
559	Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	790	0.2
638C2	Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded	960	0.3
828B	Zenor sandy loam, 2 to 5 percent slopes	1,220	0.3
828C2	Zenor sandy loam, 5 to 9 percent slopes, moderately eroded	1,350	0.4
829D2	Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded	760	0.2
829E2	Zenor-Storden complex, 14 to 18 percent slopes, moderately eroded	240	0.1
956	Harps-Okoboji complex, 0 to 1 percent slopes	1,810	0.5
1221	Palms muck, ponded, 0 to 1 percent slopes	240	0.1
1507	Brownton silty clay loam, 0 to 2 percent slopes	38,840	10.5
1536	Hanlon fine sandy loam, channeled, 0 to 2 percent slopes	1,290	0.3
1585	Spillville-Coland complex, channeled, 0 to 2 percent slopes	5,330	1.4
2225	Blue Earth mucky silt loam, sandy substratum, 0 to 1 percent slopes	680	0.2
4000	Urban land	380	0.1
5010	Pits, sand and gravel	190	*
5030	Pits, limestone quarry	50	*
5040	Orthents, loamy	1,050	0.3

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
5043	Aquents, loamy, reclaimed, 0 to 2 percent slopes	420	0.1
	Water	503	0.1
	Total	369,563	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
27B	Terril loam, 2 to 5 percent slopes
52B	Bode clay loam, 2 to 5 percent slopes
55	Nicollet loam, 1 to 3 percent slopes
95	Harps clay loam, 0 to 2 percent slopes (where drained)
96	Turlin loam, 0 to 2 percent slopes
107	Webster silty clay loam, 0 to 2 percent slopes (where drained)
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes
135	Coland clay loam, 0 to 2 percent slopes (where drained)
138B	Clarion loam, 2 to 5 percent slopes
138B2	Clarion loam, 2 to 5 percent slopes, moderately eroded
168B	Hayden loam, 2 to 5 percent slopes
175B	Dickinson sandy loam, 2 to 5 percent slopes
201B	Coland-Terril complex, 1 to 5 percent slopes (where drained)
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
288	Ottosen clay loam, 1 to 3 percent slopes
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
355	Luther loam, 0 to 2 percent slopes (where drained)
388	Kossuth silty clay loam, 0 to 2 percent slopes (where drained)
485	Spillville loam, 0 to 2 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes (where drained)
536	Hanlon fine sandy loam, 0 to 2 percent slopes
559	Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
1507	Brownton silty clay loam, 0 to 2 percent slopes (where drained)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
4---------- Knoke	IIIw	109	35	76	3.3	3.3	4.3	5.5
6---------- Okoboji	IIIw	115	37	80	3.4	3.3	4.3	7.3
27B---------- Terril	IIe	154	46	92	6.5	4.2	7.0	8.3
27C---------- Terril	IIIe	149	44	89	6.3	4.2	6.7	8.0
48---------- Knoke	IIIw	109	35	76	3.3	3.3	4.3	5.5
52B---------- Bode	IIe	142	46	99	6.0	3.8	6.1	7.1
52C---------- Bode	IIIe	137	44	96	5.8	3.6	5.8	6.8
52C2---------- Bode	IIIe	133	43	93	5.6	3.5	5.6	6.6
55---------- Nicollet	I	156	50	109	6.2	3.5	5.5	6.5
62C2---------- Storden	IIIe	123	39	86	5.2	2.5	3.5	4.5
62D2---------- Storden	IIIe	114	36	80	4.8	2.3	3.3	4.2
62E2---------- Storden	IVe	97	31	68	4.1	2.2	3.2	4.2
62F---------- Storden	VIe	---	---	---	3.8	2.0	2.7	3.7
90---------- Okoboji	IIIw	119	38	83	3.6	3.3	4.3	7.3
95---------- Harps	IIw	125	40	87	3.8	3.3	5.0	6.6
96---------- Turlin	IIw	153	51	92	6.0	4.1	7.1	8.3
107---------- Webster	IIw	145	46	102	4.4	4.2	6.6	7.3
108B---------- Wadena	IIe	95	30	67	4.0	2.7	3.7	4.7
135---------- Coland	IIw	136	44	95	4.1	4.1	6.0	7.6
138B---------- Clarion	IIe	145	46	101	6.1	4.2	6.7	7.6

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
138B2---------- Clarion	IIe	141	45	99	5.9	3.8	6.3	7.5
138C---------- Clarion	IIIe	140	44	98	5.9	3.8	6.3	7.3
138C2---------- Clarion	IIIe	136	44	95	5.7	3.8	6.2	7.1
138D2---------- Clarion	IIIe	127	41	89	5.3	3.7	5.5	6.5
168B---------- Hayden	IIe	127	41	89	5.3	3.5	5.5	6.5
168C---------- Hayden	IIIe	122	39	85	5.1	3.5	5.5	6.5
168C2---------- Hayden	IIIe	118	37	83	5.0	3.0	5.0	6.0
168E---------- Hayden	IVe	96	31	68	4.0	3.0	5.0	6.0
175B---------- Dickinson	IIe	109	33	65	4.6	2.7	4.8	5.0
175C---------- Dickinson	IIIe	104	32	62	4.4	2.5	4.5	4.6
201B---------- Coland-Terril	IIw	140	45	97	5.0	4.1	6.5	8.0
203---------- Cylinder	IIs	137	44	96	5.5	3.8	6.2	7.1
221---------- Palms	IIIw	115	37	81	3.5	---	---	---
236B---------- Lester	IIe	136	44	95	5.7	3.5	5.6	6.5
236C2---------- Lester	IIIe	127	39	89	5.3	3.3	5.4	6.3
259---------- Biscay	IIw	131	42	92	3.9	3.5	4.3	5.2
288---------- Ottosen	I	150	47	102	5.9	4.0	6.6	7.8
308---------- Wadena	IIs	115	37	81	4.8	3.7	5.1	6.2
355---------- Luther	I	136	44	95	5.4	3.8	6.3	7.5
356G---------- Storden-Hayden	VIIe	---	---	---	---	1.6	---	---
388---------- Kossuth	IIw	134	43	94	4.0	4.0	5.9	6.9

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
485---------- Spillville	IIw	156	48	94	6.2	4.2	7.3	8.6
506---------- Wacousta	IIIw	125	40	88	3.8	2.0	7.0	7.9
507---------- Canisteo	IIw	139	44	97	4.2	3.0	4.5	5.2
508---------- Calcousta	IIIw	119	38	83	3.6	2.0	4.0	4.7
511---------- Blue Earth	IIIw	82	26	57	2.5	2.0	3.0	4.5
536---------- Hanlon	IIs	119	38	83	5.0	3.3	5.3	6.3
559---------- Talcot	IIw	125	40	88	3.8	3.3	5.0	5.7
638C2---------- Clarion-Storden	IIIe	129	41	77	5.4	3.2	3.7	5.9
828B---------- Zenor	IIIe	89	28	62	3.7	3.0	4.8	5.5
828C2---------- Zenor	IIIe	81	26	57	3.4	2.7	4.3	5.0
829D2---------- Zenor-Storden	IVe	---	---	---	3.4	2.7	4.0	4.9
829E2---------- Zenor-Storden	VIe	68	22	52	3.4	2.5	3.5	4.8
956---------- Harps-Okoboji	IIIw	120	38	84	3.6	3.4	4.7	7.0
1221---------- Palms	Vw	---	---	---	---	---	---	---
1507---------- Brownton	IIw	128	41	90	3.8	3.0	3.5	5.5
1536---------- Hanlon	Vw	---	---	---	---	3.3	---	---
1585---------- Spillville-Coland	Vw	---	---	---	---	3.4	---	---
2225---------- Blue Earth	IIIw	70	22	49	3.0	---	---	4.5
4000**. Urban land								
5010**, 5030**. Pits								

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
5040**. Orthents								
5043**. Aquents								

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
4---------- Knoke	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	White spruce, bur oak, eastern redcedar, hackberry.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
6---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
27B, 27C---------- Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---
48---------- Knoke	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	White spruce, bur oak, eastern redcedar, hackberry.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
52B, 52C, 52C2---- Bode	---	Redosier dogwood, lilac, gray dogwood, Siberian peashrub.	Eastern redcedar, Amur maple, hackberry, northern white-cedar, blue spruce, Russian-olive.	Eastern white pine, green ash.	---
55---------- Nicollet	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
62C2, 62D2, 62E2, 62F---------- Storden	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
90---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
95---------- Harps	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
96---------- Turlin	---	Northern white-cedar, American plum, lilac.	Hackberry, white spruce, eastern redcedar.	Eastern white pine, green ash.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
107---------- Webster	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
108B---------- Wadena	Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, hackberry, Manchurian crabapple.	Jack pine, honeysuckle, bur oak, green ash, eastern white pine.	---	---
135---------- Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
138B, 138B2, 138C, 138C2, 138D2----- Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
168B, 168C, 168C2, 168E---------- Hayden	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Hackberry, eastern redcedar, Russian-olive, Amur maple, northern white-cedar, blue spruce.	Eastern white pine green ash.	---
175B, 175C-------- Dickinson	Lilac----------	Eastern redcedar, Russian-olive, Tatarian honeysuckle, Siberian peashrub.	Eastern white pine, green ash, Norway spruce, honeylocust, red pine, Amur maple, hackberry.	---	---
201B*: Coland----------	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
Terril----------	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---
203---------- Cylinder	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, northern white-cedar, Amur maple, white spruce.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
221---------- Palms	Vanhoutte spirea	Silky dogwood, common ninebark, nannyberry viburnum, American cranberrybush.	Northern white-cedar, Manchurian crabapple, white spruce.	Eastern white pine, Norway spruce, green ash.	Imperial Carolina poplar.
236B, 236C2------- Lester	---	Redosier dogwood, Siberian peashrub, lilac, gray dogwood.	Hackberry, eastern redcedar, northern white-cedar, Amur maple, Russian-olive, blue spruce.	Eastern white pine, green ash.	---
259---------- Biscay	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
288---------- Ottosen	---	Redosier dogwood, lilac, Tatarian honeysuckle.	Northern white-cedar, blue spruce, white spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
308---------- Wadena	Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, hackberry, Manchurian crabapple.	Jack pine, honeysuckle, bur oak, green ash, eastern white pine.	---	---
355---------- Luther	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, green ash, Austrian pine, eastern white pine.	Silver maple.
356G*: Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
Hayden----------	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Hackberry, eastern redcedar, Russian-olive, Amur maple, northern white-cedar, blue spruce.	Eastern white pine, green ash.	---
388---------- Kossuth	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Tall purple willow, Amur maple, hackberry, white spruce, northern white-cedar.	Golden willow, green ash.	Eastern cottonwood. silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
485---------- Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
506---------- Wacousta	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, eastern redcedar, bur oak, white spruce.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
507---------- Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
508---------- Calcousta	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
511---------- Blue Earth	---	Redosier dogwood	Tall purple willow	Black willow, golden willow, white willow.	---
536---------- Hanlon	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
559---------- Talcot	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, white spruce, bur oak, eastern redcedar.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
638C2*: Clarion----------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
828B, 828C2------- Zenor	Siberian peashrub, Tatarian honeysuckle, lilac.	Hackberry, eastern redcedar, Manchurian crabapple.	Honeylocust, bur oak, jack pine, green ash, Russian-olive, eastern white pine.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
829D2*, 829E2*: Zenor	Siberian peashrub, Tatarian honeysuckle, lilac.	Hackberry, eastern redcedar, Manchurian crabapple.	Honeylocust, bur oak, jack pine, green ash, Russian-olive, eastern white pine.	---	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
956*: Harps	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
1221. Palms					
1507--- Brownton	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	White spruce, hackberry, bur oak, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
1536--- Hanlon	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
1585*: Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
2225--- Blue Earth	---	Siberian peashrub, northern white-cedar, lilac, Tatarian honeysuckle.	Eastern redcedar, white spruce, hackberry.	Green ash, golden willow.	Eastern cottonwood.
4000*. Urban land					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
5010*, 5030*. Pits					
5040*. Orthents					
5043*. Aquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
4---------- Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
6---------- Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
27B---------- Terril	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
27C---------- Terril	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
48---------- Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
52B---------- Bode	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
52C, 52C2---------- Bode	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
55---------- Nicollet	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
62C2---------- Storden	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
62D2---------- Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
62E2, 62F---------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
90---------- Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
95---------- Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
96---------- Turlin	Severe: flooding, excess humus.	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Moderate: flooding.
107---------- Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
108B---------- Wadena	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
135---------- Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
138B, 138B2---------- Clarion	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
138C, 138C2---------- Clarion	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
138D2---------- Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
168B---------- Hayden	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
168C, 168C2---------- Hayden	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
168E---------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
175B---------- Dickinson	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
175C---------- Dickinson	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
201B*: Coland----------	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Terril----------	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
203---------- Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----------	Slight.
221---------- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
236B---------- Lester	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
236C2---------- Lester	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
259---------- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
288---------- Ottosen	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight----------	Slight.
308---------- Wadena	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
355---------- Luther	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
356G*: Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hayden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
388--- Kossuth	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
485--- Spillville	Severe: flooding.	Slight---	Moderate: flooding.	Slight---	Moderate: flooding.
506--- Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
507--- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
508--- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
511--- Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
536--- Hanlon	Severe: flooding.	Slight---	Moderate: flooding.	Slight---	Moderate: flooding.
559--- Talcot	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
638C2*: Clarion---	Slight---	Slight---	Severe: slope.	Slight---	Slight.
Storden---	Slight---	Slight---	Severe: slope.	Slight---	Slight.
828B--- Zenor	Slight---	Slight---	Moderate: slope, small stones.	Slight---	Slight.
828C2--- Zenor	Slight---	Slight---	Severe: slope.	Slight---	Slight.
829D2*: Zenor---	Slight---	Slight---	Severe: slope.	Slight---	Slight.
Storden---	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight---	Moderate: slope.
829E2*: Zenor---	Slight---	Slight---	Severe: slope.	Slight---	Slight.
Storden---	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
956*: Harps---	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Okoboji---	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1221---------- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
1507---------- Brownton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
1536---------- Hanlon	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
1585*: Spillville----------	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Coland----------	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
2225---------- Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
4000*. Urban land					
5010*, 5030*. Pits					
5040*. Orthents					
5043*. Aquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
4---------- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
6---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
27B---------- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
27C---------- Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
48---------- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
52B---------- Bode	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
52C, 52C2---------- Bode	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
55---------- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
62C2, 62D2, 62E2--- Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
62F---------- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
90---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
95---------- Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
96---------- Turlin	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
107---------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
108B---------- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
135---------- Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
138B, 138B2-------- Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
138C, 138C2, 138D2- Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
168B---------- Hayden	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
168C, 168C2, 168E--Hayden	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
175B--Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
175C--Dickinson	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
201B*:										
Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
203--Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
221--Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
236B--Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
236C2--Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
259--Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
288--Ottosen	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
308--Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
355--Luther	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
356G*:										
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Hayden	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
388--Kossuth	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
485--Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
506--Wacousta	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
507--Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
508--Calcousta	Good	Good	Fair	Good	Good	Good	Good	Good	Good	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
511---- Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
536---- Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
559---- Talcot	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
638C2*:										
Clarion----	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden----	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
828B---- Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
828C2---- Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
829D2*, 829E2*:										
Zenor----	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden----	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
956*:										
Harps----	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Okoboji----	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
1221---- Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
1507---- Brownton	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
1536---- Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
1585*:										
Spillville----	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Coland----	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
2225---- Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
4000*. Urban land										
5010*, 5030*. Pits										

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
5040*. Orthents										
5043*. Aquents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
4 Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
6 Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
27B Terril	Slight	Slight	Slight	Slight	Severe: low strength.	Slight.
27C Terril	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
48 Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
52B Bode	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.	Slight.
52C, 52C2 Bode	Slight	Moderate: shrink-swell.	Slight	Moderate: slope, shrink-swell.	Severe: low strength.	Slight.
55 Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
62C2 Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
62D2 Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
62E2, 62F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
90 Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
95 Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
96 Turlin	Severe: cutbanks cave, excess humus.	Severe: flooding, low strength.	Severe: flooding.	Severe: flooding, low strength.	Severe: flooding.	Moderate: flooding.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
107--- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
108B--- Wadena	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Slight.
135--- Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
138B, 138B2--- Clarion	Slight---	Slight---	Slight---	Slight---	Moderate: frost action.	Slight.
138C, 138C2--- Clarion	Slight---	Slight---	Slight---	Moderate: slope.	Moderate: frost action.	Slight.
138D2--- Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
168B--- Hayden	Slight---	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
168C, 168C2--- Hayden	Slight---	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
168E--- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
175B--- Dickinson	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Moderate: frost action.	Slight.
175C--- Dickinson	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Moderate: frost action.	Slight.
201B*: Coland---	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Terril---	Slight---	Slight---	Slight---	Slight---	Severe: low strength.	Slight.
203--- Cylinder	Severe: cutbanks cave, wetness.	Moderate: shrink-swell, wetness.	Severe: wetness.	Moderate: shrink-swell, wetness.	Severe: frost action.	Slight.
221--- Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
236B--- Lester	Slight---	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
236C2---------- Lester	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
259---------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
288---------- Ottosen	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
308---------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
355---------- Luther	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: frost action, shrink-swell.	Moderate: wetness.
356G*: Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hayden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
388---------- Kossuth	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
485---------- Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
506---------- Wacousta	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
507---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
508---------- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
511---------- Blue Earth	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
536---------- Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
559---------- Talcot	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
638C2*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
828B Zenor	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
828C2 Zenor	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
829D2*:						
Zenor	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
829E2*:						
Zenor	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
956*:						
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
1221 Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
1507 Brownton	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
1536 Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
1585*:						
Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Severe: flooding.
Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: flooding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
2225---------- Blue Earth	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
4000*. Urban land						
5010*, 5030*. Pits						
5040*. Orthents						
5043*. Aquents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
4 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
6 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
27B Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
27C Terril	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
48 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
52B Bode	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
52C, 52C2 Bode	Slight	Severe: slope.	Slight	Slight	Good.
55 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
62C2 Storden	Slight	Severe: slope.	Slight	Slight	Good.
62D2 Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
62E2, 62F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
90 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
95 Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
96 Turlin	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack.
107 Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
108B---------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
135---------- Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
138B, 138B2--------- Clarion	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
138C, 138C2--------- Clarion	Slight----------	Severe: slope.	Slight----------	Slight----------	Good.
138D2---------- Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
168B---------- Hayden	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
168C, 168C2--------- Hayden	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
168E---------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
175B---------- Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
175C---------- Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
201B*: Coland----------	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
Terril----------	Slight----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
203---------- Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
221---------- Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
236B---------- Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
236C2---------- Lester	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
259---------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
288---------- Ottosen	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
308---------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
355---------- Luther	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
356G*:					
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Hayden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
388---------- Kossuth	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
485---------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
506---------- Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
507---------- Canisteo	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
508---------- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
511---------- Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
536---------- Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
559---------- Talcot	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
638C2*: Clarion	Slight	Severe: slope.	Slight	Slight	Good.
Storden	Slight	Severe: slope.	Slight	Slight	Good.
828B Zenor	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
828C2 Zenor	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
829D2*: Zenor	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
829E2*: Zenor	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
956*: Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
1221 Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
1507 Brownton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1536 Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
1585*: Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1585*: Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
2225 Blue Earth	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: hard to pack, ponding.
4000*. Urban land					
5010*, 5030*. Pits					
5040*. Orthents					
5043*. Aquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
4 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
6 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
27B, 27C Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
48 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
52B, 52C, 52C2 Bode	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
55 Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
62C2 Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
62D2 Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
62E2, 62F Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
90 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
95 Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
96 Turlin	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
107 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
108B Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
135---------- Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
138B, 138B2, 138C, 138C2---------- Clarion	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
138D2---------- Clarion	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
168B, 168C, 168C2----- Hayden	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
168E---------- Hayden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
175B, 175C---------- Dickinson	Good----------	Probable----------	Improbable: too sandy.	Good.
201B*: Coland----------	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Terril----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
203---------- Cylinder	Fair: wetness.	Probable----------	Improbable: too sandy.	Fair: area reclaim, small stones, thin layer.
221---------- Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
236B, 236C2---------- Lester	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
259---------- Biscay	Fair: wetness.	Probable----------	Probable----------	Fair: area reclaim, thin layer.
288---------- Ottosen	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
308---------- Wadena	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
355---------- Luther	Fair: wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
356G*: Storden----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hayden----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
388--- Kossuth	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
485--- Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
506--- Wacousta	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
507--- Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
508--- Calcousta	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
511--- Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
536--- Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
559--- Talcot	Fair: wetness.	Probable	Probable	Fair: small stones, area reclaim, thin layer.
638C2*: Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
828B, 828C2--- Zenor	Good	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
829D2*: Zenor	Good	Probable	Improbable: too sandy.	Fair: small stones, thin layer, slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
829E2*: Zenor	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
956*: Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1221 Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
1507 Brownton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
1536 Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1585*: Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
2225 Blue Earth	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
4000*. Urban land				
5010*, 5030*. Pits				
5040*. Orthents				
5043*. Aquents				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
4---- Knoke	Slight	Severe: hard to pack, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding, erodes easily.	Wetness, erodes easily.
6---- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.
27B, 27C---- Terril	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
48---- Knoke	Slight	Severe: hard to pack, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding, erodes easily.	Wetness, erodes easily.
52B, 52C, 52C2---- Bode	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
55---- Nicollet	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Frost action	Wetness	Favorable.
62C2---- Storden	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
62D2, 62E2, 62F---- Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
90---- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.
95---- Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
96---- Turlin	Moderate: seepage.	Severe: piping, excess humus.	Severe: cutbanks cave.	Deep to water	Favorable	Favorable.
107---- Webster	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
108B---- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy	Favorable.
135---- Coland	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
138B, 138B2, 138C, 138C2---- Clarion	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
138D2---------- Clarion	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
168B, 168C, 168C2- Hayden	Moderate: seepage, slope.	Slight---------	Severe: no water.	Deep to water	Favorable------	Favorable.
168E---------- Hayden	Severe: slope.	Slight---------	Severe: no water.	Deep to water	Slope----------	Slope.
175B, 175C-------- Dickinson	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Soil blowing, too sandy.	Favorable.
201B*: Coland----------	Moderate: seepage, slope.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action, slope.	Wetness--------	Wetness.
Terril----------	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
203---------- Cylinder	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Favorable.
221---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
236B, 236C2------- Lester	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
259---------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
288---------- Ottosen	Moderate: seepage.	Moderate: piping, wetness.	Severe: slow refill.	Frost action---	Wetness--------	Favorable.
308---------- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
355---------- Luther	Moderate: seepage.	Severe: piping, wetness.	Severe: slow refill.	Frost action---	Wetness--------	Rooting depth.
356G*: Storden----------	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Hayden----------	Severe: slope.	Slight---------	Severe: no water.	Deep to water	Slope----------	Slope.
388---------- Kossuth	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Frost action---	Wetness--------	Wetness, rooting depth.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
485---------- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
506---------- Wacousta	Moderate: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Not needed-----	Not needed.
507---------- Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
508---------- Calcousta	Moderate: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.
511---------- Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding--------	Wetness.
536---------- Hanlon	Severe: seepage.	Severe: piping.	Severe: cutbanks cave.	Deep to water	Soil blowing---	Favorable.
559---------- Talcot	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
638C2*: Clarion----------	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
Storden----------	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
828B, 828C2------- Zenor	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Favorable.
829D2*, 829E2*: Zenor----------	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing, slope.	Slope.
Storden----------	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
956*: Harps----------	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
Okoboji----------	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.
1221---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
1507---------- Brownton	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Percs slowly, frost action.	Wetness--------	Wetness, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
1536---------- Hanlon	Severe: seepage.	Severe: piping.	Severe: cutbanks cave.	Deep to water	Soil blowing---	Favorable.
1585*: Spillville-------	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
Coland----------	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
2225---------- Blue Earth	Severe: seepage.	Severe: piping, excess humus, ponding.	Severe: cutbanks cave.	Ponding, frost action.	Ponding--------	Wetness.
4000*. Urban land						
5010*, 5030*. Pits						
5040*. Orthents						
5043*. Aquents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
4---------- Knoke	0-8	Silty clay loam	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	8-15	Silty clay loam, mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	15-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
6---------- Okoboji	0-28	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	28-36	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	36-60	Silty clay loam, silty clay, clay loam.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
27B, 27C---------- Terril	0-32	Loam----------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	32-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
48---------- Knoke	0-8	Mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	8-15	Silty clay loam, mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	15-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
52B, 52C, 52C2--- Bode	0-18	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-90	55-80	35-50	15-25
	18-42	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	75-90	55-80	35-50	15-25
	42-60	Loam----------	CL, CL-ML	A-4, A-6	0-5	90-100	90-95	75-90	50-75	25-40	5-15
55---------- Nicollet	0-18	Loam----------	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
	18-36	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	36-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
62C2, 62D2, 62E2, 62F---------- Storden	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
90---------- Okoboji	0-28	Mucky silty clay loam.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	28-36	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	36-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
95---------- Harps	0-23	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	23-40	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	40-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
96---------- Turlin	0-34	Loam----------	OL, ML, CL	A-4, A-6	0	100	100	95-100	60-70	30-40	5-15
	34-45	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	55-70	25-35	5-15
	45-60	Loam, sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	90-100	85-95	15-40	15-30	2-10

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
107----------	0-16	Silty clay loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
Webster	16-40	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	40-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
108B----------	0-17	Loam----------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
Wadena	17-32	Loam, sandy loam, sandy clay loam.	SM, ML, SM-SC, CL-ML	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	32-60	Stratified gravelly coarse sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
135----------	0-39	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
Coland	39-51	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	51-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
138B, 138B2, 138C, 138C2, 138D2----------	0-18	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
Clarion	18-36	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	36-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
168B, 168C, 168C2, 168E-----	0-11	Loam----------	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
Hayden	11-46	Clay loam, loam	CL	A-7, A-6	0	95-100	90-100	80-95	55-75	30-50	15-26
	46-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-100	75-90	35-70	20-35	8-15
175B, 175C-------	0-11	Sandy loam-------	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
Dickinson	11-34	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	34-49	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
	49-60	Sand, loamy fine sand, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
201B*:											
Coland----------	0-39	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	39-51	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	51-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
Terril----------	0-32	Loam----------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	32-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
203----------	0-18	Loam----------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	10-25
Cylinder	18-37	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	37-60	Gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-10	75-95	75-95	20-55	5-25	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
221----------	0-46	Sapric material	PT	A-8	---	---	---	---	---	---	---
Palms	46-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
236B, 236C2------	0-9	Loam----------	ML, CL	A-6, A-4	0-5	95-100	90-100	80-95	50-70	30-40	5-15
Lester	9-47	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	47-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
259----------	0-20	Clay loam--------	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	10-25
Biscay	20-39	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	39-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
288----------	0-15	Clay loam--------	CL, CH	A-7	0	95-100	95-100	90-100	65-85	40-55	20-30
Ottosen	15-40	Clay loam, silty clay loam.	CL, CH	A-7	0	95-100	95-100	90-100	65-85	40-55	20-30
	40-60	Loam----------	CL	A-4, A-6	0-5	90-100	90-100	80-95	60-75	25-40	8-20
308----------	0-17	Loam----------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
Wadena	17-34	Loam, sandy loam, sandy clay loam.	SM, ML, SM-SC, CL-ML	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	34-60	Stratified gravelly coarse sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
355----------	0-11	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	50-65	25-40	5-15
Luther	11-40	Clay loam--------	CL	A-6	0-5	95-100	90-100	75-90	50-65	25-40	15-25
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	75-90	50-65	25-40	5-20
356G*:											
Storden---------	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Hayden----------	0-11	Loam----------	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	11-46	Clay loam, loam	CL	A-7, A-6	0	95-100	90-100	80-95	55-75	30-50	15-26
	46-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-100	75-90	35-70	20-35	8-15
388----------	0-18	Silty clay loam	CL, CH	A-7	0	95-100	95-100	80-85	75-85	40-60	20-30
Kossuth	18-38	Silty clay loam, clay loam, clay.	CL, CH	A-7	0	95-100	95-100	80-85	75-85	45-65	25-35
	38-60	Loam----------	CL	A-4, A-6	0-5	95-100	90-100	70-85	50-70	25-40	8-20
485----------	0-36	Loam----------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
Spillville	36-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
506----------	0-11	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-65	20-40
Wacousta	11-18	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	90-100	90-100	40-60	20-35
	18-60	Silt loam, silty clay loam.	CL, ML	A-6, A-4	0-5	95-100	95-100	85-100	80-90	30-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
507---------- Canisteo	0-20	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	20-44	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	44-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
508---------- Calcousta	0-13	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-65	20-40
	13-24	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	90-100	90-100	40-60	20-35
	24-60	Silty clay loam, silt loam.	CL, ML	A-6, A-4	0-5	95-100	95-100	85-100	80-90	30-40	5-15
511---------- Blue Earth	0-13	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	13-28	Mucky silty clay loam, clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
	28-60	Clay loam, loam, silt loam.	CL, ML	A-6, A-7	0	95-100	90-100	80-100	70-95	35-50	11-20
536---------- Hanlon	0-41	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	41-60	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
559---------- Talcot	0-22	Silty clay loam	CL	A-7	0	100	100	80-90	60-85	40-50	15-25
	22-38	Clay loam, silty clay loam, loam.	CL	A-7	0	95-100	85-100	70-90	60-85	40-50	15-25
	38-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, SW	A-1	0	65-90	50-85	20-50	2-10	---	NP
638C2*:											
Clarion----------	0-18	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	18-36	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	36-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Storden----------	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
828B, 828C2------ Zenor	0-12	Sandy loam-------	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	60-70	25-40	15-25	5-10
	12-32	Sandy loam, loam	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	50-70	25-40	15-25	5-10
	32-60	Gravelly loamy sand, gravelly sand, loamy sand.	SW, SP, SP-SM	A-1	0-5	85-95	80-90	20-40	3-12	<20	NP-5
829D2*, 829E2*:											
Zenor----------	0-12	Sandy loam-------	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	60-70	25-40	15-25	5-10
	12-32	Sandy loam, loam	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	50-70	25-40	15-25	5-10
	32-60	Gravelly loamy sand, gravelly sand, loamy sand.	SW, SP, SP-SM	A-1	0-5	85-95	80-90	20-40	3-12	<20	NP-5
Storden----------	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
956*:											
Harps	0-23	Clay loam	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	23-40	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	40-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
Okoboji	0-28	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	28-36	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	36-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
1221	0-46	Sapric material	PT	A-8	---	---	---	---	---	---	---
Palms	46-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
1507	0-22	Silty clay loam, silty clay.	MH, CH	A-7	0	100	98-100	90-98	85-95	50-65	20-35
Browntown	22-38	Silty clay, clay	MH, CH	A-7	0	100	98-100	90-98	85-95	50-80	25-40
	38-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-98	75-90	60-75	30-50	15-25
1536	0-29	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
Hanlon	29-38	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
	38-60	Loam, sandy loam, loamy sand.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2	0	100	100	80-90	20-60	15-35	5-15
1585*:											
Spillville	0-36	Loam	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	36-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
Coland	0-39	Silty clay loam	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	39-51	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	51-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
2225	0-24	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
Blue Earth	24-42	Mucky silt loam, loam.	OL, ML	A-5	0	95-100	95-100	80-95	80-95	41-50	2-8
	42-60	Loamy sand	SP-SM, SM	A-2	0	100	100	65-90	10-35	---	NP
4000*. Urban land											
5010*, 5030*. Pits											
5040*. Orthents											
5043*. Aquents											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
4----------	0-8	27-38	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High----------	0.37	5	7
Knoke	8-15	27-38	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High----------	0.37		
	15-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
6----------	0-28	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High----------	0.37	5	4
Okoboji	28-36	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37		
	36-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
27B, 27C----------	0-32	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6
Terril	32-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----------	0.32		
48----------	0-8	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High----------	0.37	5	7
Knoke	8-15	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High----------	0.37		
	15-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
52B, 52C, 52C2---	0-18	28-36	1.40-1.50	0.6-2.0	0.17-0.19	6.1-7.3	Moderate------	0.28	5	6
Bode	18-42	28-38	1.50-1.70	0.6-2.0	0.15-0.19	6.1-7.3	Moderate------	0.28		
	42-60	22-27	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.28		
55----------	0-18	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6
Nicollet	18-36	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32		
	36-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low-----------	0.32		
62C2, 62D2, 62E2, 62F----------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L
Storden	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
90----------	0-28	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High----------	0.37	5	4
Okoboji	28-36	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37		
	36-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
95----------	0-23	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate------	0.24	5	4L
Harps	23-40	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32		
	40-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32		
96----------	0-34	18-26	1.45-1.55	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6
Turlin	34-45	20-28	1.55-1.65	0.6-2.0	0.17-0.19	5.6-7.3	Low-----------	0.32		
	45-60	8-18	1.65-1.70	6.0-20	0.08-0.17	6.1-7.3	Low-----------	0.24		
107----------	0-16	26-35	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate------	0.24	5	6
Webster	16-40	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate------	0.32		
	40-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32		
108B----------	0-17	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	4	5
Wadena	17-32	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low-----------	0.32		
	32-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low-----------	0.10		
135----------	0-39	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28	5	7
Coland	39-51	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28		
	51-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low-----------	0.28		
138B, 138B2, 138C, 138C2, 138D2----------	0-18	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6
Clarion	18-36	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37		
	36-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
168B, 168C, 168C2, 168E----- Hayden	0-11	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.32	5	6
	11-46	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32		
	46-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32		
175B, 175C------- Dickinson	0-11	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low----------	0.20	4	3
	11-34	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low----------	0.20		
	34-49	4-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low----------	0.20		
	49-60	4-10	1.60-1.70	6.0-20	0.02-0.04	5.6-7.3	Low----------	0.15		
201B*:										
Coland----------	0-39	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
	39-51	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	51-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		
Terril----------	0-32	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
	32-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
203--------------- Cylinder	0-18	22-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6
	18-37	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32		
	37-60	2-12	1.60-1.70	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
221--------------- Palms	0-46	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	----------	----	2	2
	46-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----		
236B, 236C2------ Lester	0-9	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6
	9-47	24-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28		
	47-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-8.4	Low----------	0.37		
259--------------- Biscay	0-20	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
	20-39	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	39-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10		
288--------------- Ottosen	0-15	29-40	1.35-1.45	0.2-0.6	0.19-0.22	5.6-7.3	Moderate-----	0.28	5	4
	15-40	29-40	1.45-1.55	0.2-0.6	0.17-0.19	6.1-8.4	Moderate-----	0.28		
	40-60	22-27	1.55-1.85	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
308--------------- Wadena	0-17	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5
	17-34	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	34-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
355--------------- Luther	0-11	18-26	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	5	6
	11-40	30-35	1.50-1.70	0.2-0.6	0.16-0.18	5.1-7.3	High---------	0.32		
	40-60	23-30	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
356G*:										
Storden---------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
Hayden----------	0-11	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.32	5	6
	11-46	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32		
	46-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32		
388--------------- Kossuth	0-18	32-42	1.35-1.45	0.2-0.6	0.21-0.23	6.1-7.3	High---------	0.28	5	4
	18-38	33-42	1.45-1.55	0.2-0.6	0.18-0.20	6.1-7.8	High---------	0.28		
	38-60	23-27	1.55-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.28		
485--------------- Spillville	0-36	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	36-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
506--------------- Wacousta	0-11	27-35	1.20-1.25	0.6-2.0	0.21-0.23	6.1-7.8	High---------	0.28	5	7
	11-18	24-35	1.25-1.30	0.6-2.0	0.18-0.20	6.6-7.8	High---------	0.43		
	18-60	18-30	1.30-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.43		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
507----------	0-20	18-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32	5	4L
Canisteo	20-44	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32		
	44-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32		
508----------	0-13	27-35	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28	5	7
Calcousta	13-24	24-32	1.30-1.40	0.6-2.0	0.18-0.20	7.4-8.4	High---------	0.43		
	24-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.43		
511----------	0-13	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L
Blue Earth	13-28	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Low----------	0.28		
	28-60	18-32	1.30-1.60	0.2-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28		
536----------	0-41	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low----------	0.20	5	3
Hanlon	41-60	5-10	1.55-1.70	2.0-6.0	0.11-0.13	5.6-7.3	Low----------	0.20		
559----------	0-22	27-35	1.20-1.30	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.28	4	7
Talcot	22-38	25-35	1.25-1.35	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.28		
	38-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15		
638C2*:										
Clarion---------	0-18	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6
	18-36	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37		
	36-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
Storden---------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
828B, 828C2------	0-12	14-18	1.50-1.55	2.0-6.0	0.14-0.16	5.6-7.3	Low----------	0.20	4	3
Zenor	12-32	14-18	1.55-1.60	2.0-6.0	0.13-0.15	6.1-8.4	Low----------	0.20		
	32-60	2-8	1.60-1.75	6.0-20	0.06-0.09	7.9-8.4	Low----------	0.10		
829D2*, 829E2*:										
Zenor----------	0-12	14-18	1.50-1.55	2.0-6.0	0.14-0.16	5.6-7.3	Low----------	0.20	4	3
	12-32	14-18	1.55-1.60	2.0-6.0	0.13-0.15	6.1-8.4	Low----------	0.20		
	32-60	2-8	1.60-1.75	6.0-20	0.06-0.09	7.9-8.4	Low----------	0.10		
Storden---------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
956*:										
Harps----------	0-23	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate-----	0.24	5	4L
	23-40	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.32		
	40-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
Okoboji---------	0-28	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High---------	0.37	5	4
	28-36	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37		
	36-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37		
1221---------	0-46	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	----------	----	2	2
Palms	46-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----		
1507----------	0-22	35-55	1.20-1.30	0.06-0.2	0.18-0.22	7.4-8.4	High---------	0.28	5	4
Brownton	22-38	35-55	1.20-1.30	0.06-0.2	0.13-0.16	7.4-8.4	High---------	0.28		
	38-60	25-35	1.45-1.70	0.2-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28		
1536----------	0-29	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low----------	0.20	5	3
Hanlon	29-38	5-10	1.55-1.70	2.0-6.0	0.11-0.13	5.6-7.3	Low----------	0.20		
	38-60	2-18	1.55-1.70	2.0-6.0	0.12-0.19	5.6-7.8	Low----------	0.20		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
1585*:										
Spillville------	0-36	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	36-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
Coland----------	0-39	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
	39-51	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	51-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		
2225----------	0-24	18-26	0.20-0.80	2.0-6.0	0.35-0.48	7.4-8.4	Low----------	0.28	5	5
Blue Earth	24-42	18-26	0.20-1.80	0.6-2.0	0.18-0.24	7.4-8.4	Low----------	0.28		
	42-60	3-10	1.50-1.65	6.0-20	0.02-0.04	6.1-8.4	Low----------	0.10		
4000*. Urban land										
5010*, 5030*. Pits										
5040*. Orthents										
5043*. Aquents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "occasional," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
4---------- Knoke	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
6---------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
27B, 27C---------- Terril	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
48---------- Knoke	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
52B, 52C, 52C2---- Bode	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
55---------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
62C2, 62D2, 62E2, 62F---------- Storden	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
90---------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
95---------- Harps	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
96---------- Turlin	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Moderate.
107---------- Webster	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
108B---------- Wadena	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
135---------- Coland	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
138B, 138B2, 138C, 138C2, 138D2----- Clarion	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
168B, 168C, 168C2, 168E---------- Hayden	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
175B, 175C-------- Dickinson	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
201B*: Coland----------	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
Terril----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
203---------- Cylinder	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
221---------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
236B, 236C2------- Lester	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
259---------- Biscay	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
288---------- Ottosen	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
308---------- Wadena	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
355---------- Luther	B	None--------	---	---	1.5-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
356G*: Storden----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Hayden----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
388---------- Kossuth	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
485---------- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Moderate.
506---------- Wacousta	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
507---------- Canisteo	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
508---------- Calcousta	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
511---------- Blue Earth	B/D	None--------	---	---	+2-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
536---------- Hanlon	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	Moderate	Low.
559---------- Talcot	B/D	None--------	---	---	1.0-2.5	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
638C2*:												
Clarion----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Storden----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
828B, 828C2------- Zenor	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
829D2*, 829E2*:												
Zenor----------	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
Storden----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
956*:												
Harps----------	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
Okoboji----------	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
1221---------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
1507---------- Brownton	C/D	None--------	---	---	1.0-2.5	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
1536---------- Hanlon	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	Moderate	Low.
1585*:												
Spillville-------	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Moderate.
Colani----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
2225---------- Blue Earth	B/D	None--------	---	---	+2-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
4000*. Urban land												

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
5010*, 5030*. Pits												
5040*. Orthents												
5043*. Aquents												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aquents	Loamy, mixed, mesic Mollic Haplaquents
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Bode	Fine-loamy, mixed, mesic Typic Hapludolls
Brownton	Fine, montmorillonitic (calcareous), mesic Typic Haplaquolls
Calcousta	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Hayden	Fine-loamy, mixed, mesic Typic Hapludalfs
Knoke	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Kossuth	Fine-loamy, mixed, mesic Typic Haplaquolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Luther	Fine-loamy, mixed, mesic Aeric Ochraqualfs
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Orthents	Loamy, mixed, mesic Typic Udorthents
Ottosen	Fine-loamy, mixed, mesic Aquic Hapludolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Talcot	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Turlin	Fine-loamy, mixed, mesic Cumulic Hapludolls
Wacousta	Fine-silty, mixed, mesic Typic Haplaquolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Zenor	Coarse-loamy, mixed, mesic Typic Hapludolls

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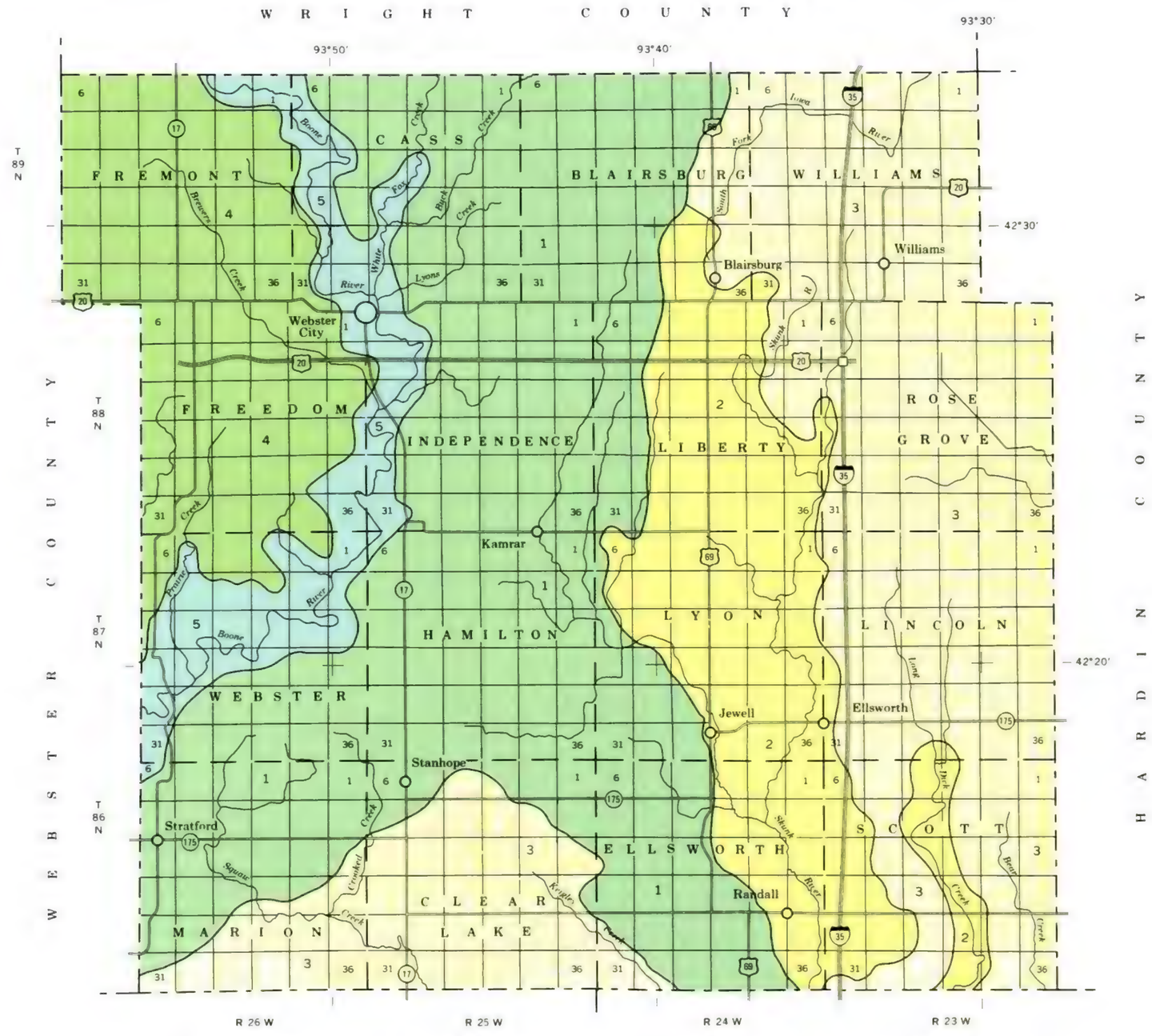


Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

LEGEND*

1 — BROWNTON-OTTOSEN-BODE association: Nearly level to moderately sloping, poorly drained, somewhat poorly drained, and well drained, silty and loamy soils formed in glacial or lacustrine sediments and in the underlying glacial till; on uplands

2 — CLARION-CANISTEO-STORDEN association: Nearly level to moderately steep, well drained and poorly drained, loamy and silty soils formed in glacial sediments and glacial till; on uplands

3 — CANISTEO-CLARION-NICOLLET association: Nearly level to moderately sloping, poorly drained, well drained, and somewhat poorly drained, silty and loamy soils formed in glacial sediments and glacial till; on uplands

4 — CANISTEO-NICOLLET-WEBSTER association: Nearly level and very gently sloping, poorly drained and somewhat poorly drained, silty and loamy soils formed in glacial sediments and glacial till; on uplands

5 — HAYDEN-STORDEN-HANLON association: Nearly level to very steep, well drained and moderately well drained, loamy soils formed in glacial till and alluvium; on uplands and bottom land

*Texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

COMPILED 1984

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1	
7	8	9	10	11	12	
18	17	16	15	14	13	
19	20	21	22	23	24	
30	29	28	27	26	25	
31	32	33	34	35	36	

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

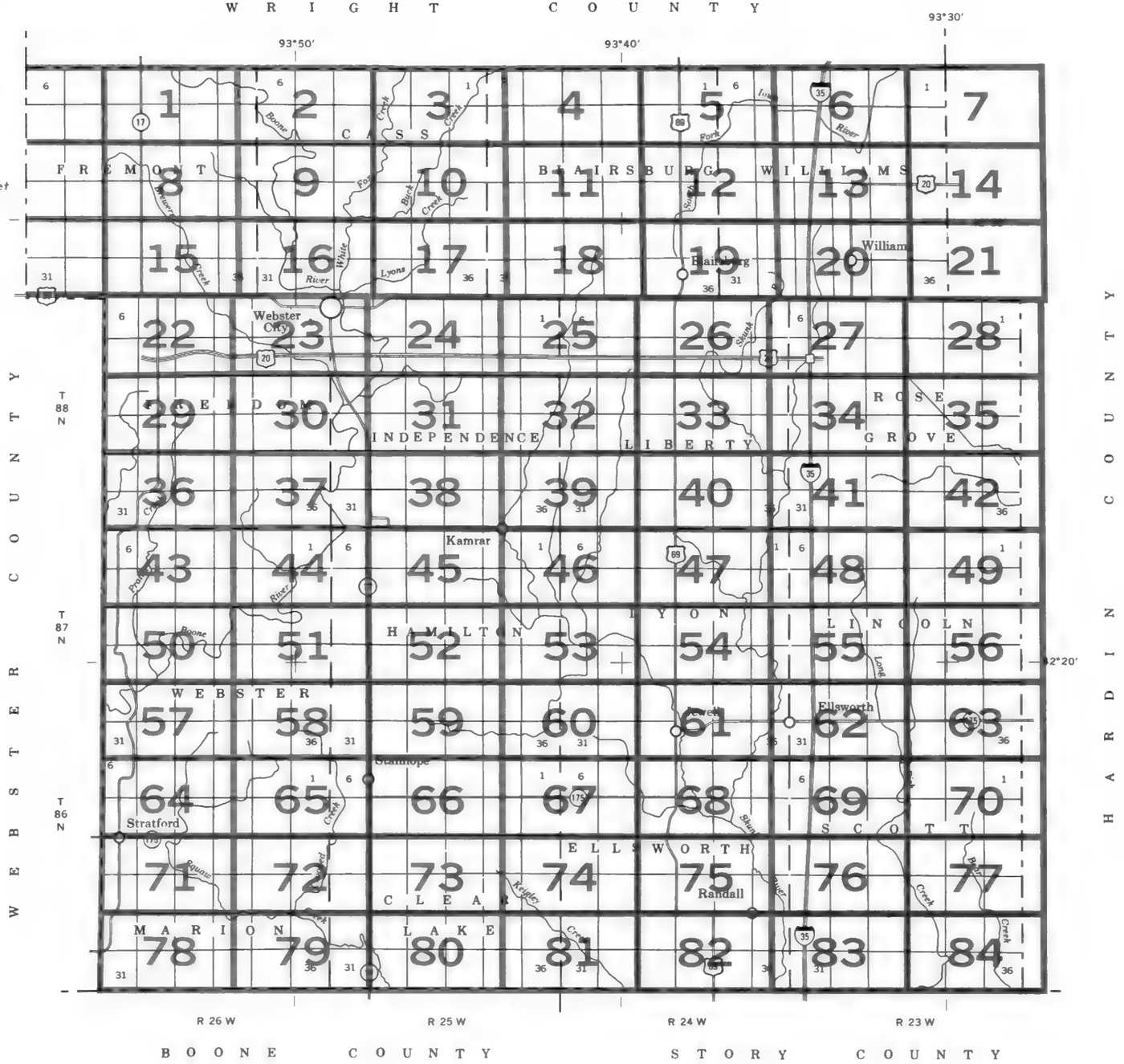
GENERAL SOIL MAP

HAMILTON COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km



N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

HAMILTON COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

HAMILTON COUNTY, IOWA

IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is moderately eroded.

SYMBOL	NAME
4	Knoke silty clay loam, 0 to 1 percent slopes
6	Okoboji silty clay loam, 0 to 1 percent slopes
27B	Terril loam, 2 to 5 percent slopes
27C	Terril loam, 5 to 9 percent slopes
48	Knoke mucky silty clay loam, 0 to 1 percent slopes
52B	Bode clay loam, 2 to 5 percent slopes
52C	Bode clay loam, 5 to 9 percent slopes
52C2	Bode clay loam, 5 to 9 percent slopes, moderately eroded
55	Nicollet loam, 1 to 3 percent slopes
62C2	Storden loam, 5 to 9 percent slopes,moderately eroded
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded
62E2	Storden loam, 14 to 18 percent slopes, moderately eroded
62F	Storden loam, 18 to 25 percent slopes
90	Okoboji mucky silty clay loam, 0 to 1 percent slopes
95	Harps clay loam, 0 to 2 percent slopes
96	Turlin loam, 0 to 2 percent slopes
107	Webster silty clay loam, 0 to 2 percent slopes
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes
135	Coland clay loam, 0 to 2 percent slopes
138B	Clarion loam, 2 to 5 percent slopes
138B2	Clarion loam, 2 to 5 percent slopes, moderately eroded
138C	Clarion loam, 5 to 9 percent slopes
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded
168B	Hayden loam, 2 to 5 percent slopes
168C	Hayden loam, 5 to 9 percent slopes
168C2	Hayden loam, 5 to 9 percent slopes, moderately eroded
168E	Hayden loam, 14 to 18 percent slopes
175B	Dickinson sandy loam, 2 to 5 percent slopes
175C	Dickinson sandy loam, 5 to 9 percent slopes
201B	Coland-Terril complex, 1 to 5 percent slopes
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
221	Palms muck, 0 to 1 percent slopes
236B	Lester loam, 2 to 5 percent slopes
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
288	Ottosen clay loam, 1 to 3 percent slopes
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
355	Luther loam, 0 to 2 percent slopes
356G	Storden-Hayden loams, 25 to 50 percent slopes
388	Kossuth silty clay loam, 0 to 2 percent slopes
485	Spillville loam, 0 to 2 percent slopes
506	Wacousta silty clay loam, 0 to 1 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes
508	Calcousta silty clay loam, 0 to 1 percent slopes
511	Blue Earth mucky silt loam, 0 to 1 percent slopes
536	Hanlon fine sandy loam, 0 to 2 percent slopes
559	Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
638C2	Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded
828B	Zenor sandy loam, 2 to 5 percent slopes
828C2	Zenor sandy loam, 5 to 9 percent slopes, moderately eroded
829D2	Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded
829E2	Zenor-Storden complex, 14 to 18 percent slopes, moderately eroded
956	Harps-Okoboji complex, 0 to 1 percent slopes
1221	Palms muck, ponded, 0 to 1 percent slopes
1507	Brownton silty clay loam, 0 to 2 percent slopes
1536	Hanlon fine sandy loam, channeled, 0 to 2 percent slopes
1585	Spillville-Coland complex, channeled, 0 to 2 percent slopes
2225	Blue Earth mucky silt loam, sandy substratum, 0 to 1 percent slopes
4000	Urban land
5010	Pits, sand and gravel
5030	Pits, limestone quarry
5040	Orthents, loamy
5043	Aquents loamy, reclaimed, 0 to 2 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

County or parish

Field sheet matchline & neatline

AD HOC BOUNDARY (label)

Small airport, airfield, park, cemetery — Davis Airstrip

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

Divided (median shown if scale permits)

Other roads

ROAD EMBLEMS & DESIGNATIONS

Interstate — 70

Federal — 218

State — 52

RAILROAD

LEVEES

Without road

DAMS

Large (to scale)

Medium or small — water

PITS

Gravel pit

MISCELLANEOUS CULTURAL FEATURES

Farmstead, house (omit in urban areas)

Church

School

WATER FEATURES

DRAINAGE

Perennial, double line

Perennial, single line

Intermittent

Crossable with tillage implements

Not crossable with tillage implements

Drainage end

Canals or ditches

Double-line (label) — CANAL

Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

Perennial — water

Intermittent — dug

MISCELLANEOUS WATER FEATURES

Marsh or swamp

Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 107 55

ESCARPMENTS

Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

SOIL SAMPLE SITE — S

MISCELLANEOUS (each symbol represents 2 acres or less)

Gravelly spot

Dumps and other similar non soil areas

Rock outcrop

Sandy spot

Severely eroded spot

Calcareous spot

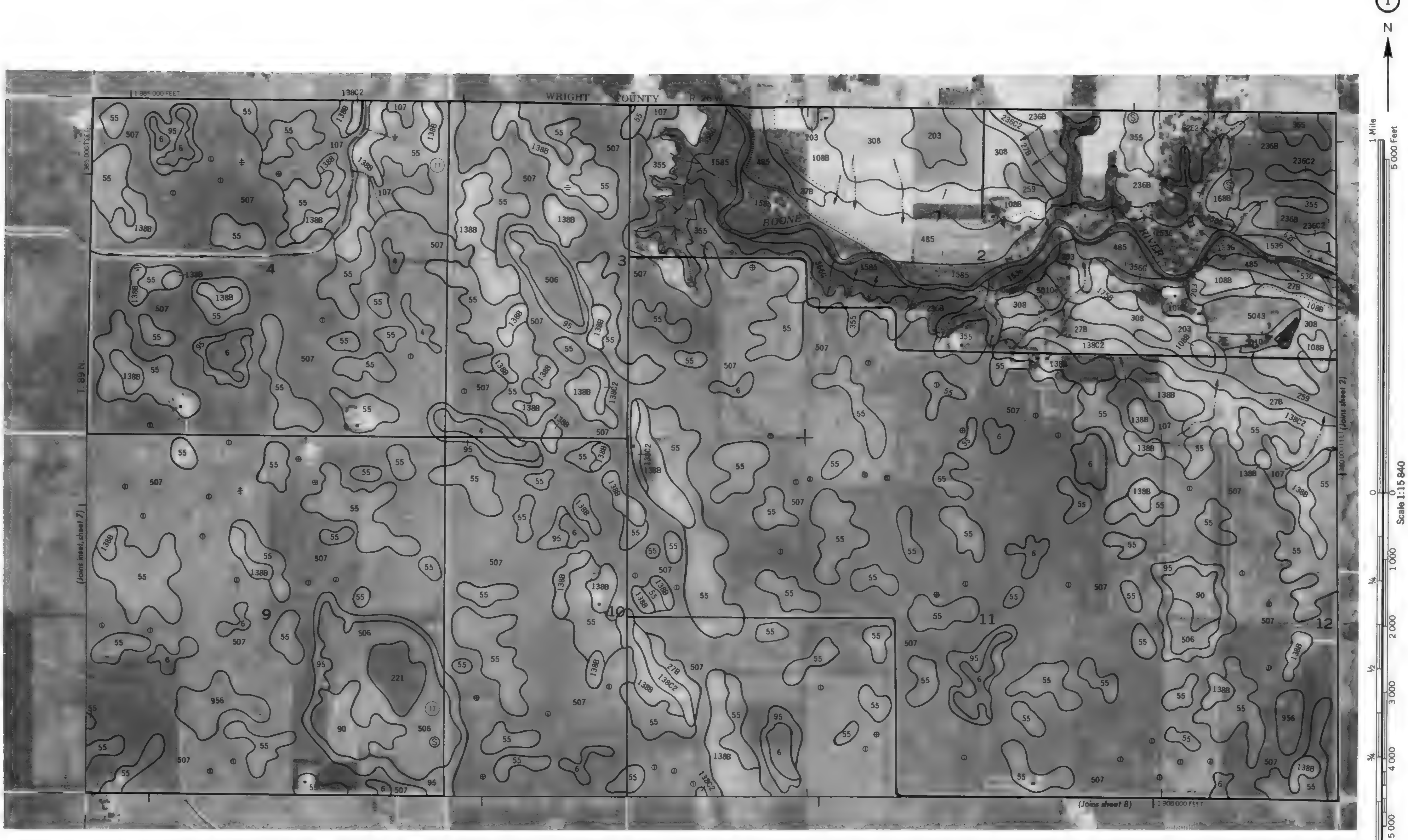
Spot of Okoboji soil

Wet depression, silt loam surface

Hump of well drained soil

Shale outcrop

Sewage lagoon — S.L.



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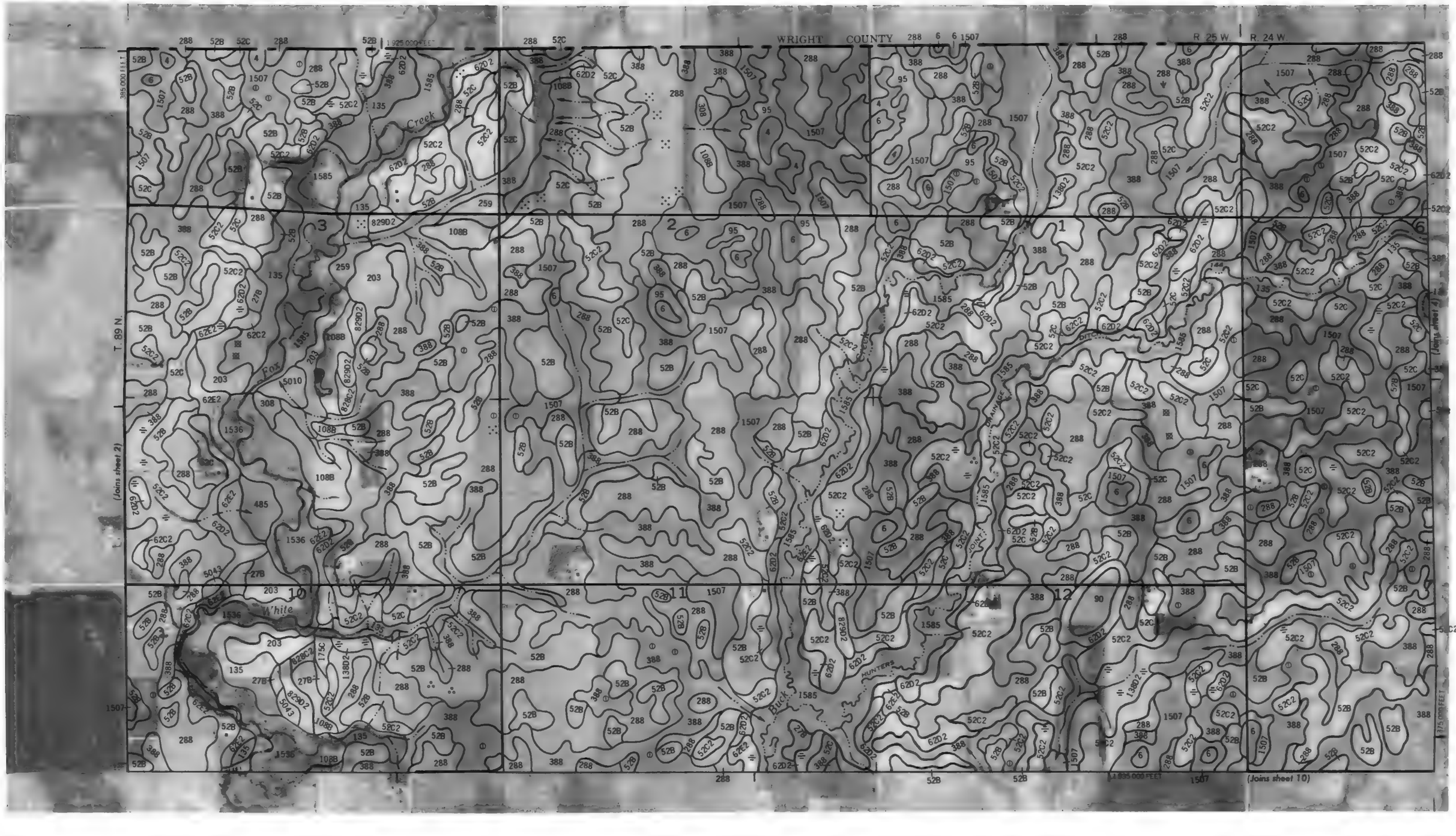
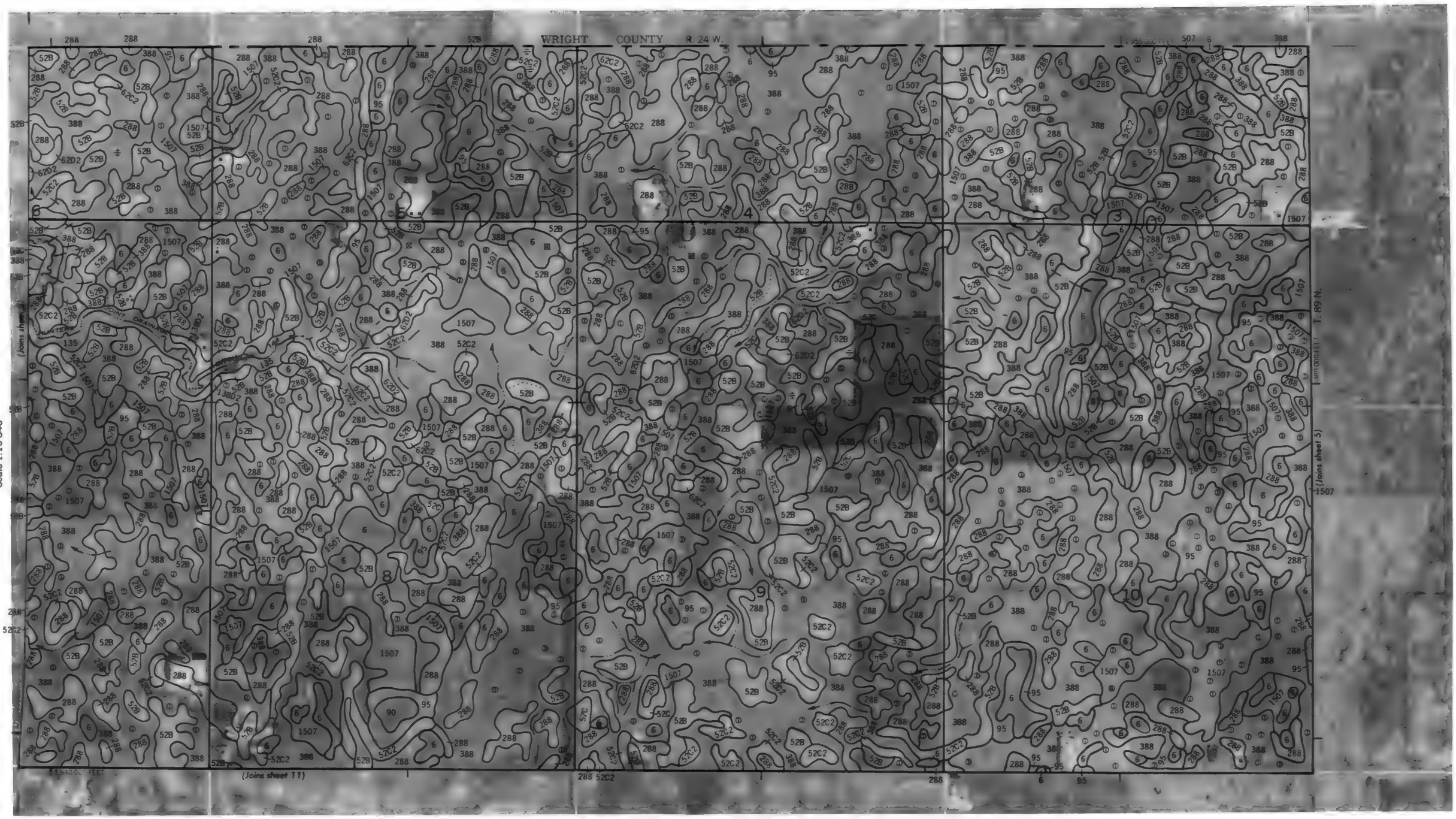
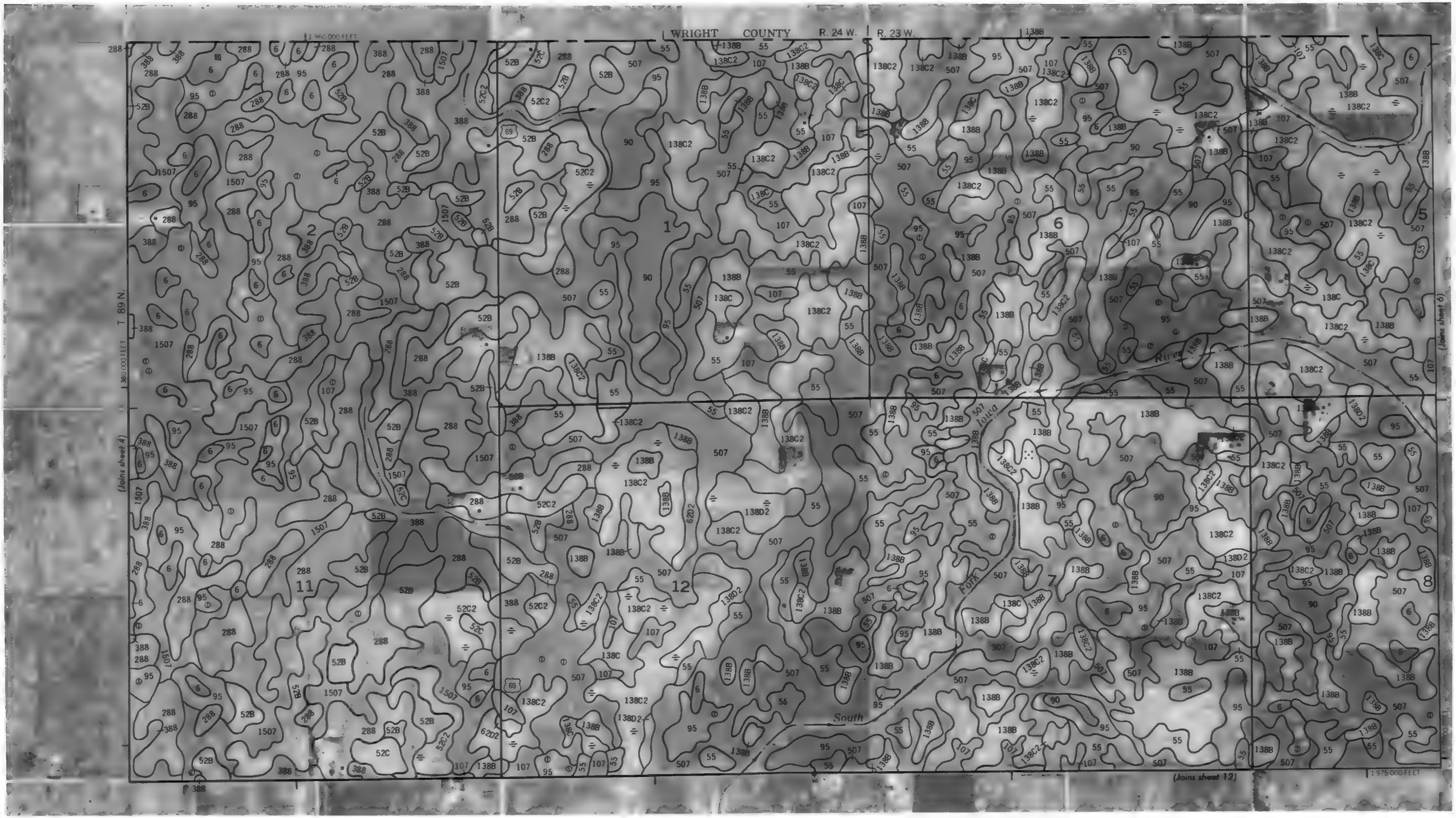
HAMILTON COUNTY, IOWA — SHEET NUMBER 2

HAMILTON COUNTY, IOWA — SHEET NUMBER 3







5

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

6

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 23 W.

WRIGHT COUNTY

T. 89 N.

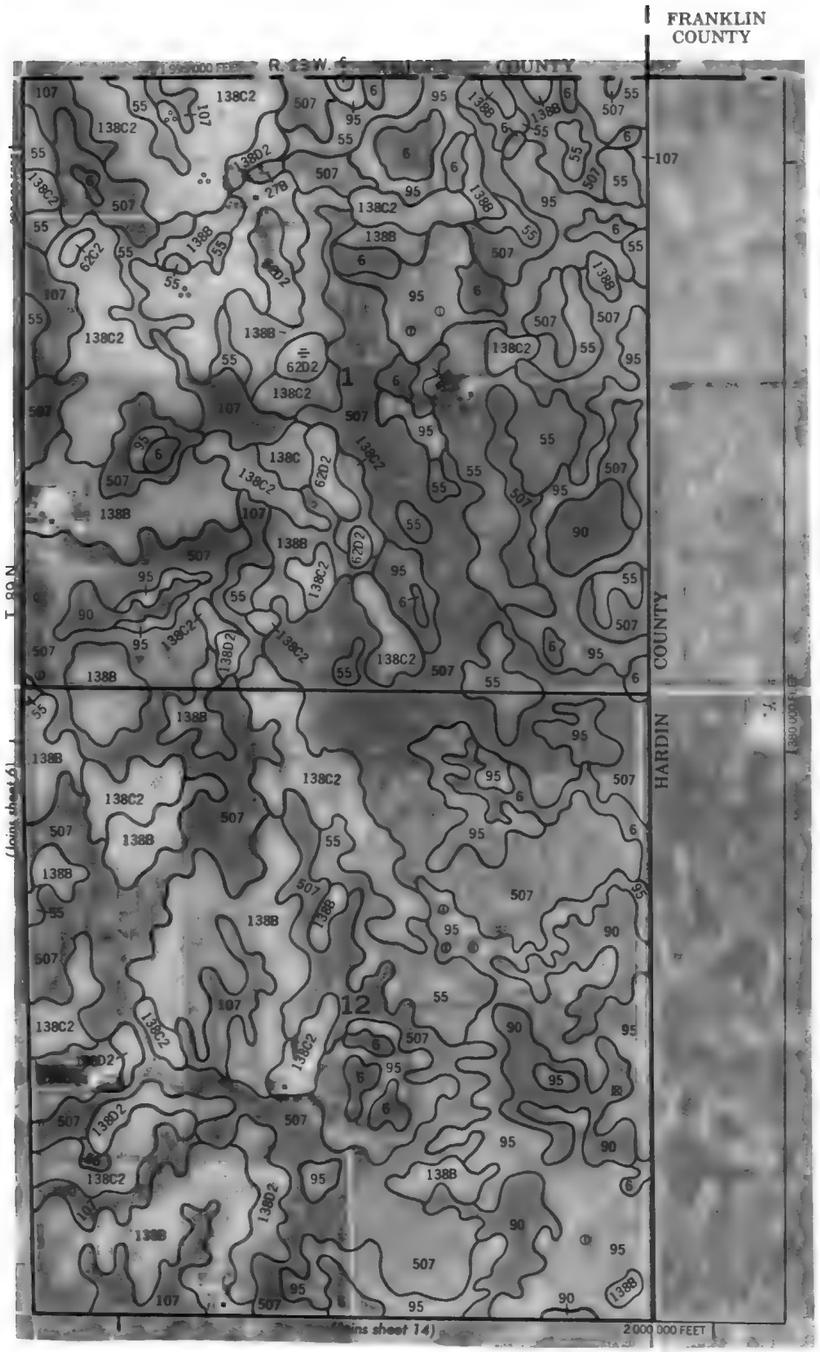
South Fork Iowa River

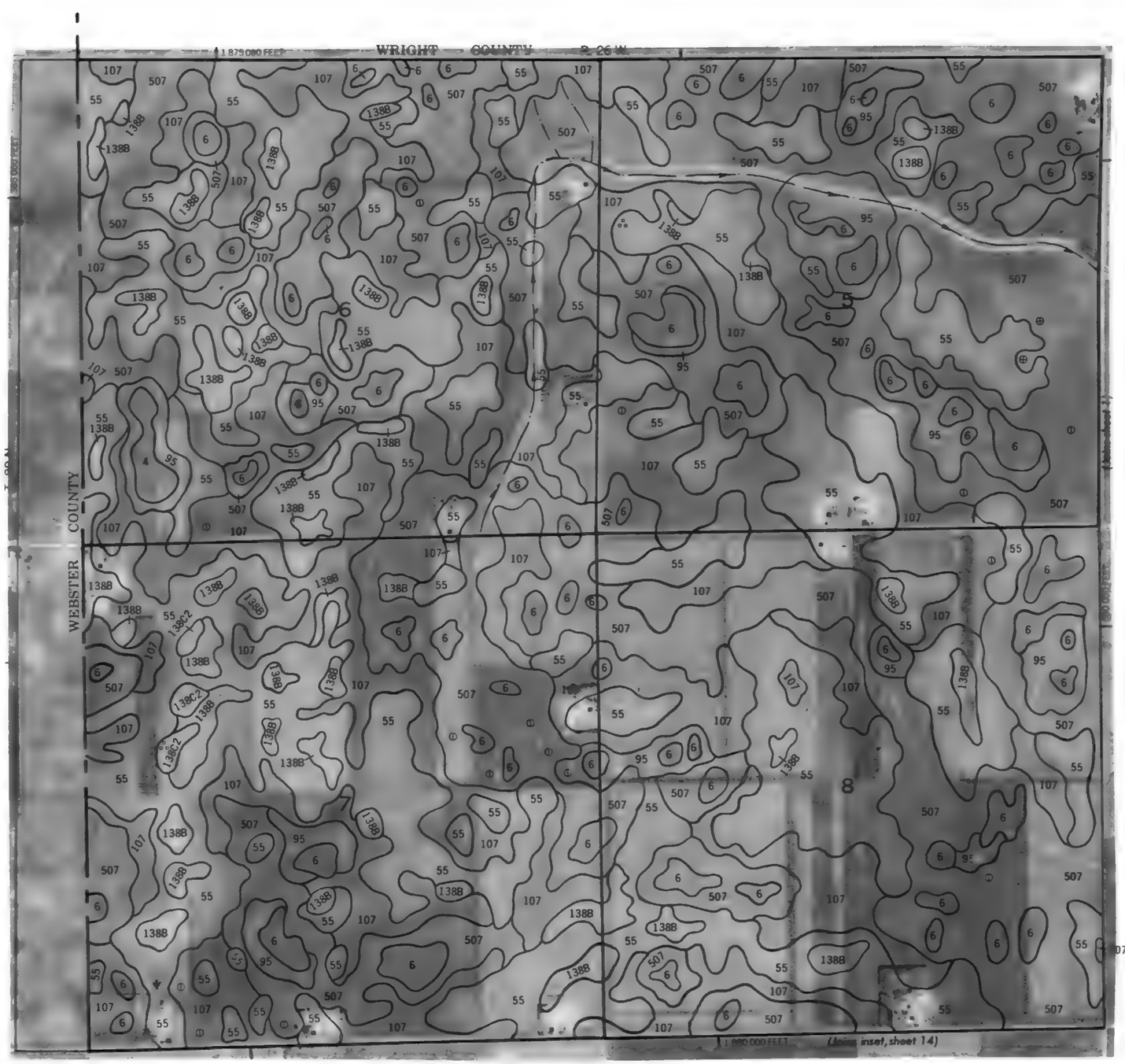
South Fork Iowa River

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 13)





7

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

8

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

5 000 0 1 000 2 000 3 000 4 000

R. 26 W.

1 900 000 FEET

1 885 000 FEET

(Joins sheet 14)

(Joins sheet 15)

(Joins sheet 9)

16

15

14

21

22

23

Beaver Creek

DITCH

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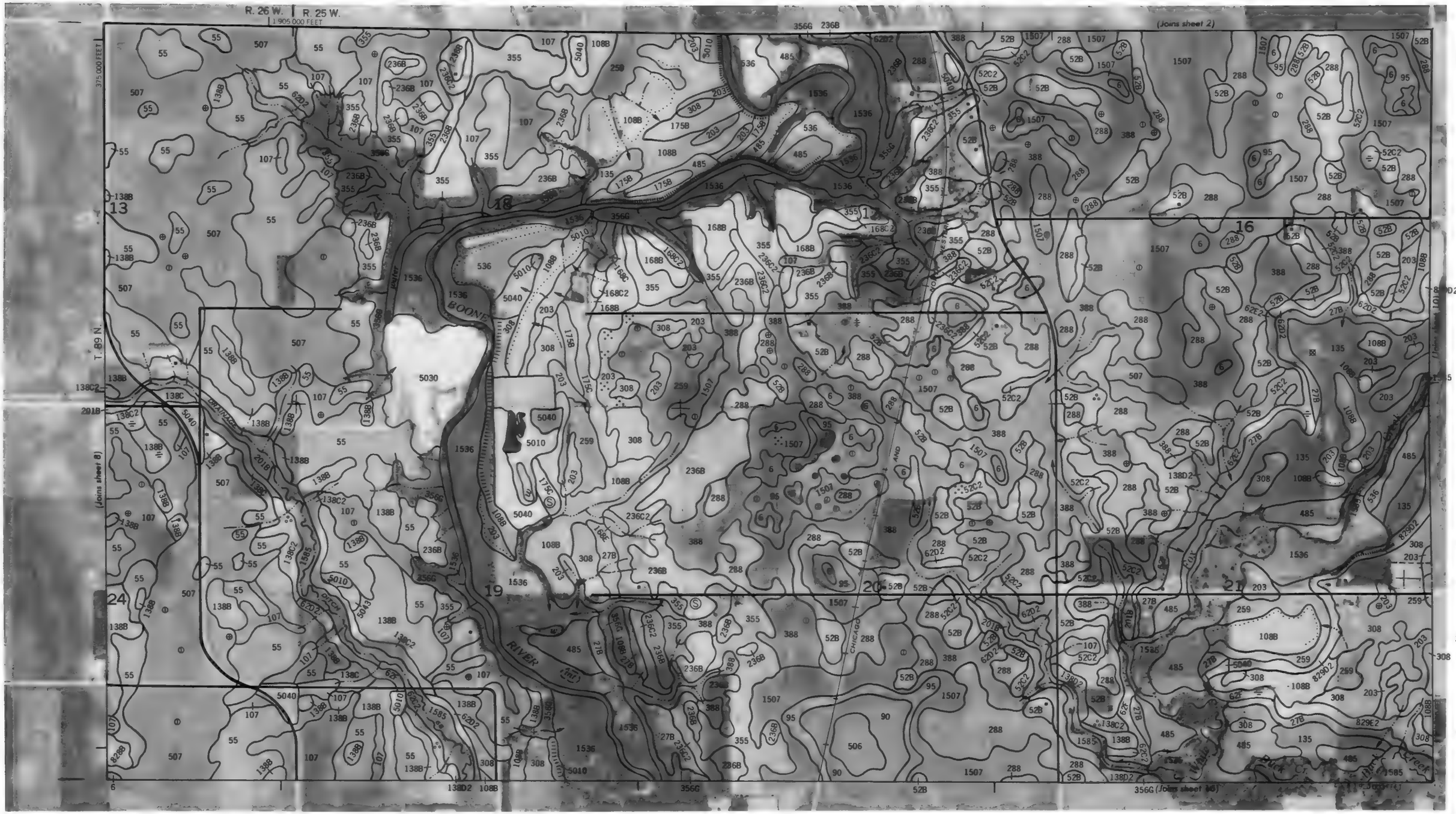


9

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 1/4 1/2 3/4 1

1 000 2 000 3 000 4 000 5 000

10

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 9)

(Joins sheet 3)

(Joins sheet 17)

(Joins sheet 11)

1 935 000 FEET

1 925 000 FEET

1 915 000 FEET

1 370 000 FEET

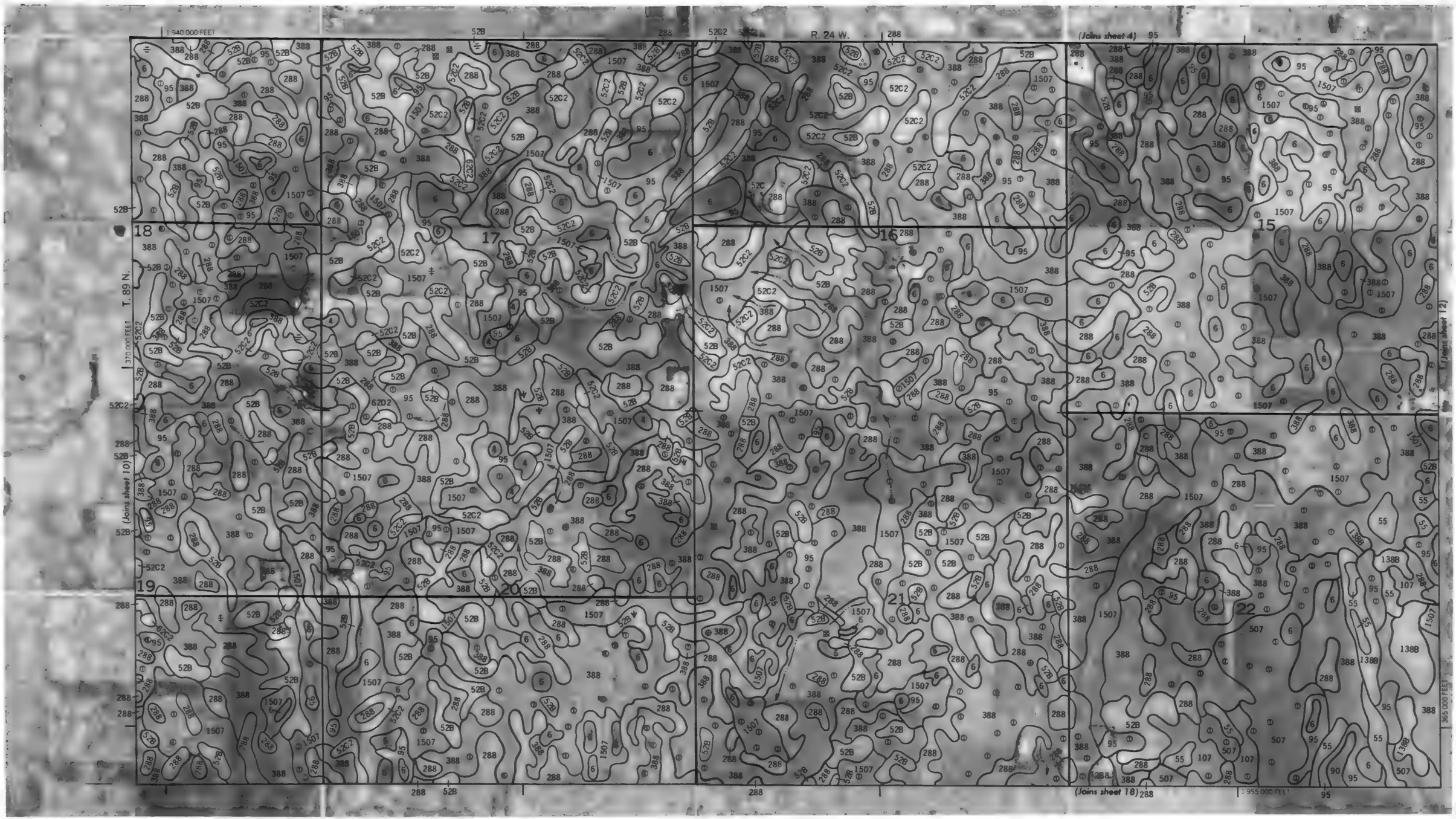
R. 25 W.

R. 24 W.

T. 89 N.

Buck Creek

Lyons Creek



11

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

12

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 24 W.

R. 23 W.

T. 89 N.

(Joins sheet 5)

(Joins sheet 11)

(Joins sheet 19)

(Joins sheet 18)

1 975 000 FEET

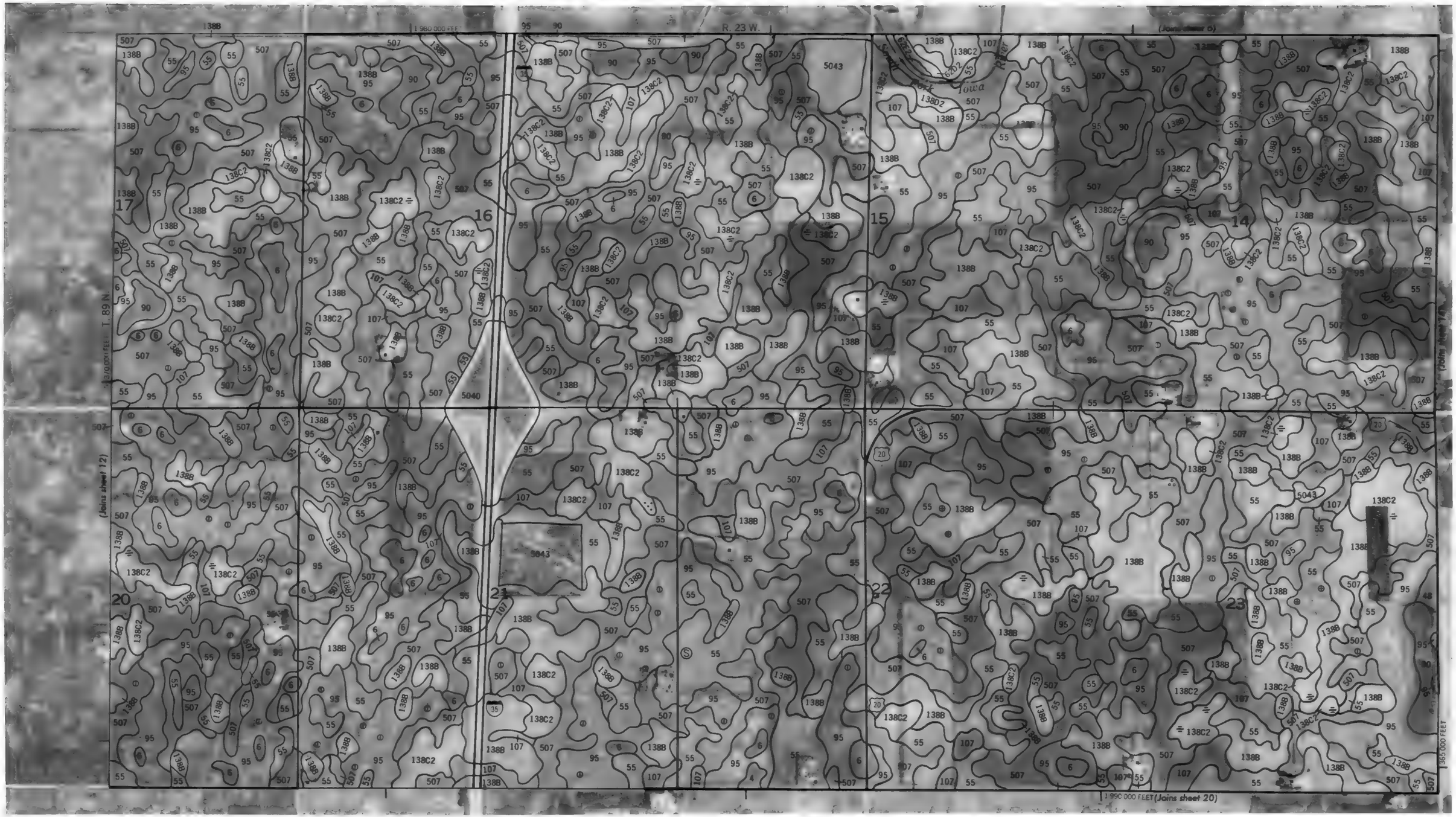
1 965 000 FEET

1 960 000 FEET

Des Moines River

North Fork

South Fork



13

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

14

N

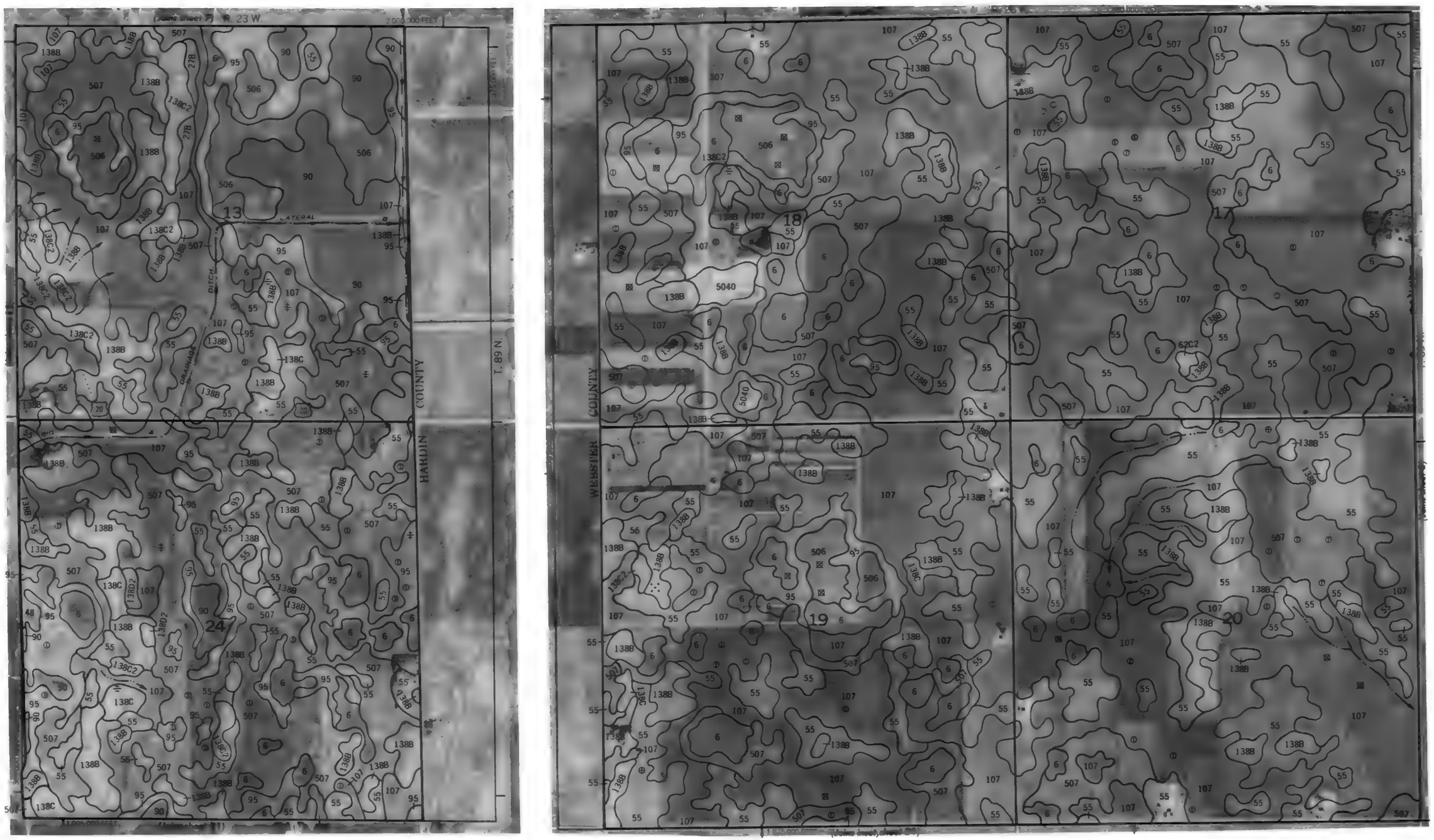
1 Mile

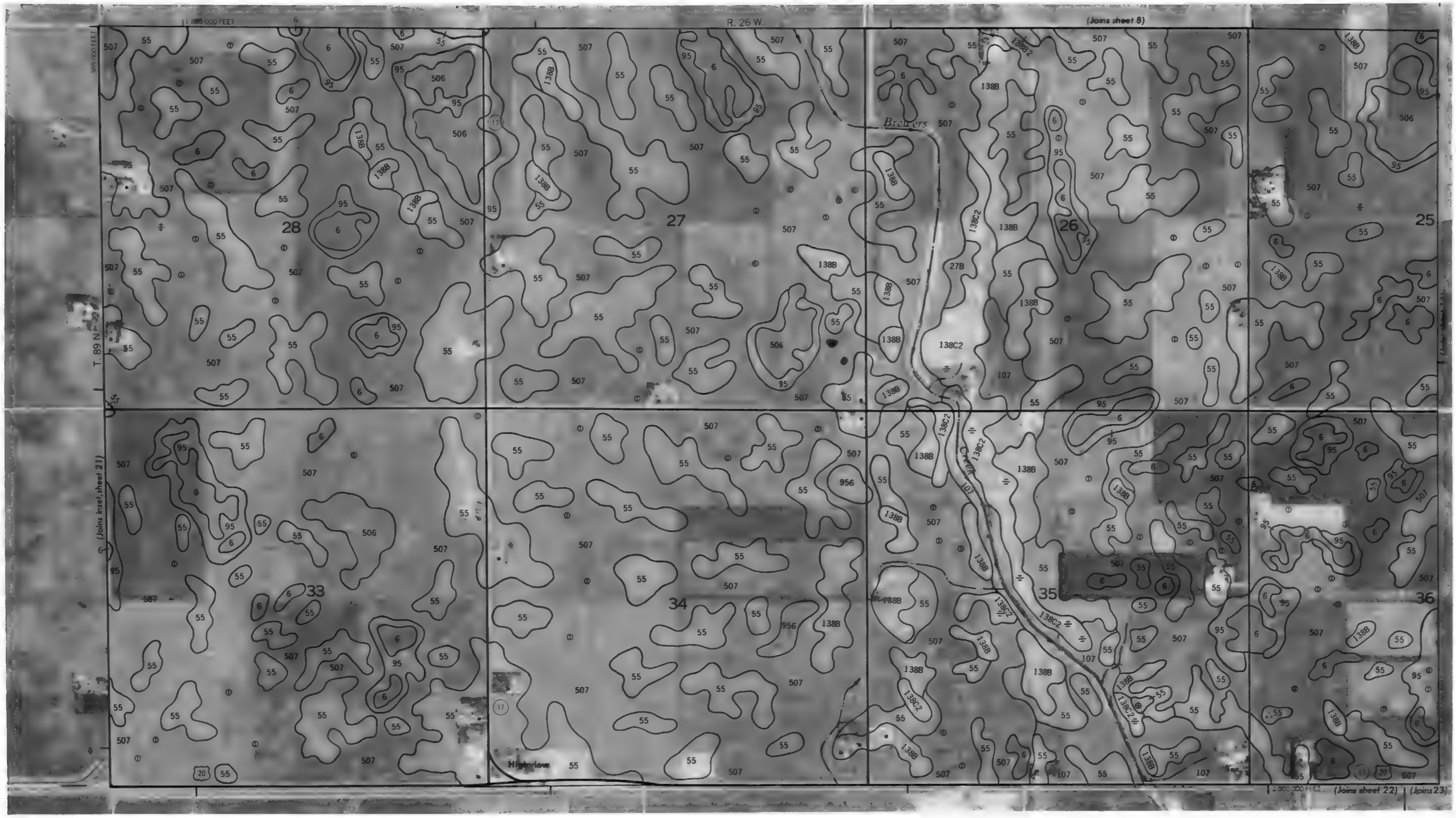
5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 0 1 000 2 000 3 000 4 000 5 000





15

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

16

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 26 W. | R. 25 W.

1388 (Joins sheet 9)

(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 23)

(Joins 24)

1 905 000 FEET

1 890 000 FEET

WEBSTER CITY
(county seat)

ILLINOIS

Buck Cr.

CHICAGO

NORTH

GULF

CENTRAL

PARK

25

30

31

32

36

28

33

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N

1 Mile 5 000 Feet

Scale 1:15 840

HAMILTON COUNTY, IOWA — SHEET NUMBER 18

18

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 11)

R. 24 W.

(Joins sheet 17)

(Joins sheet 19)

(Joins sheet 25)

(Joins sheet 26)

T. 89 N.

29

28

27

30

31

32

33

34

95

DITCH

DRAINAGE

CENTRAL

ILLINOIS

GULF

FONTEN

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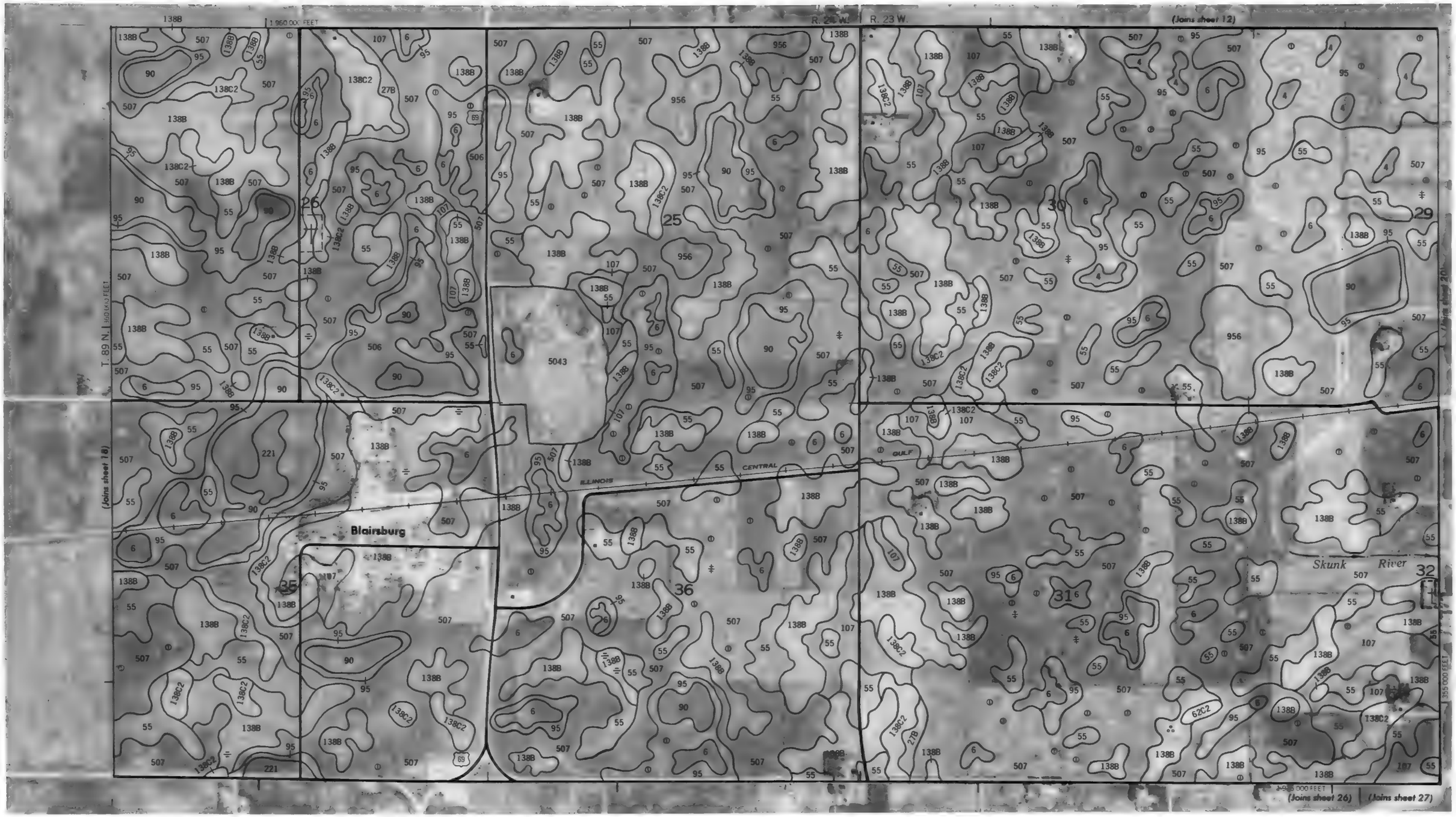


19

N

1 Mile

5,000 Feet

Scale 1:15 840

0 0 1/4 1/2 3/4 1

1 000 2 000 3 000 4 000 5 000

20

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 13)

(Joins sheet 19)

(Joins sheet 27)

(Joins 28)

R 23 W

T. 89 N.

Skunk River

Williams

GULF

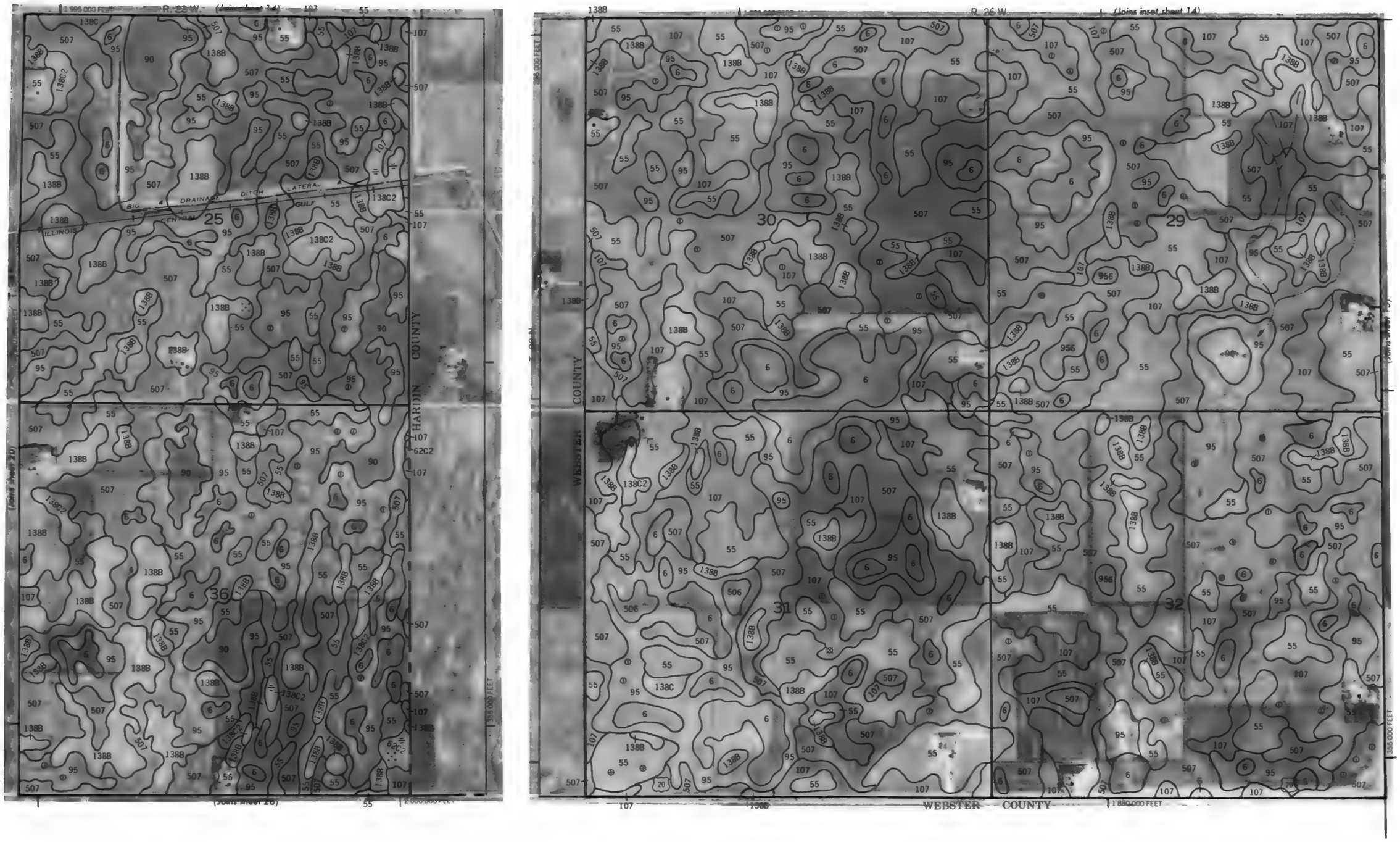
CENTRAL ILLINOIS

DRAINAGE DITCH

1 980 000 FEET

1 950 000 FEET

355 000 FEET



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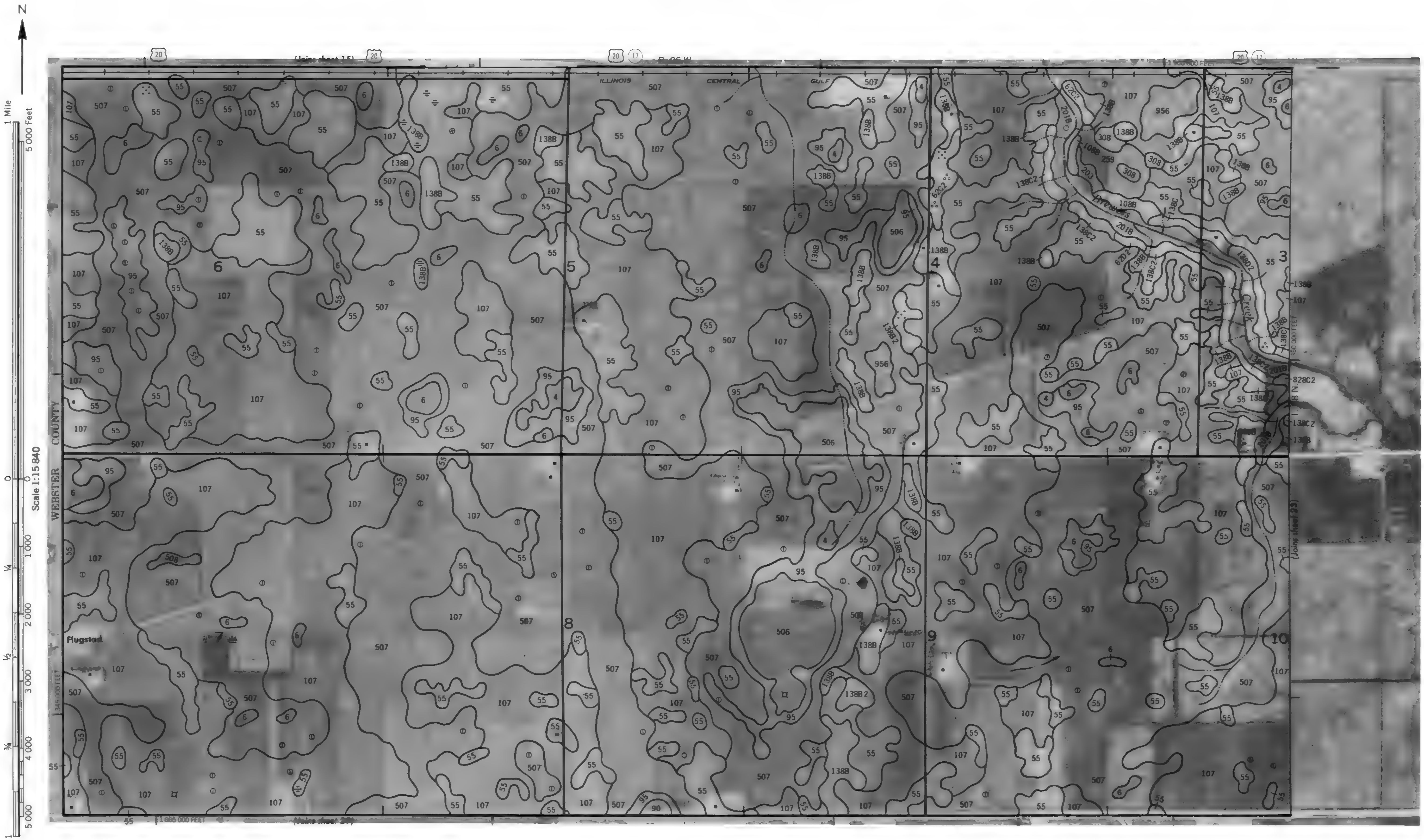
(22)



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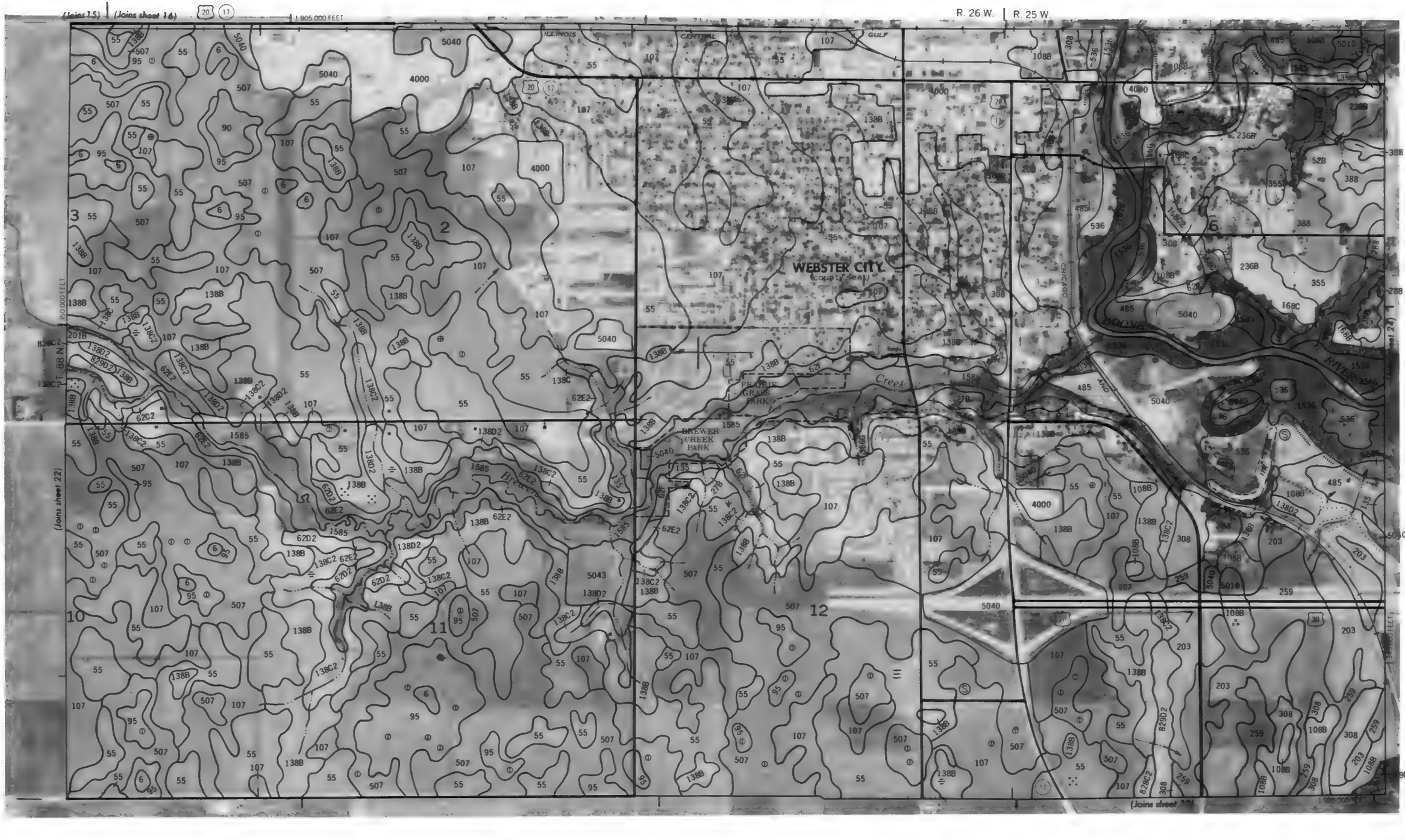

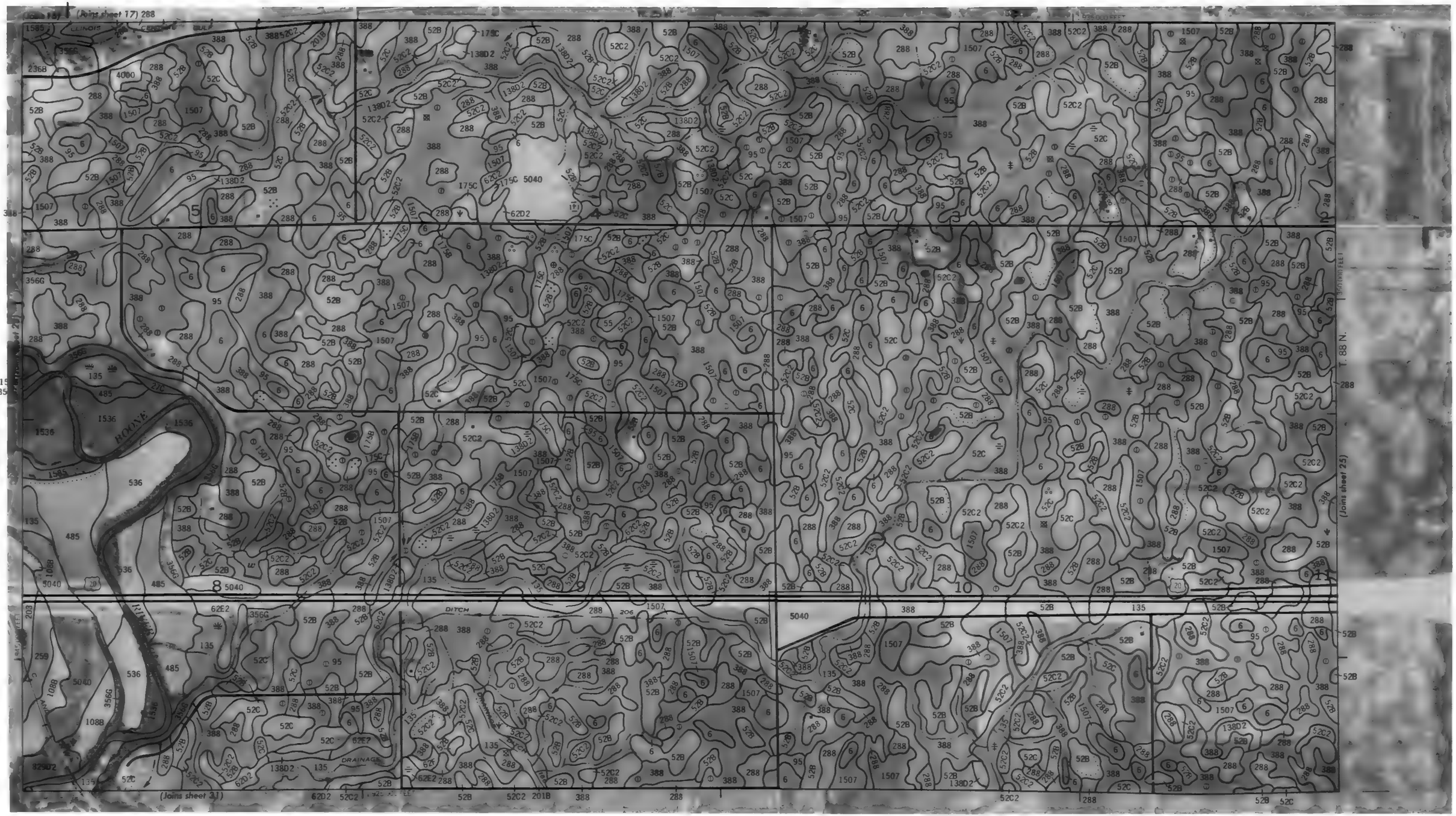

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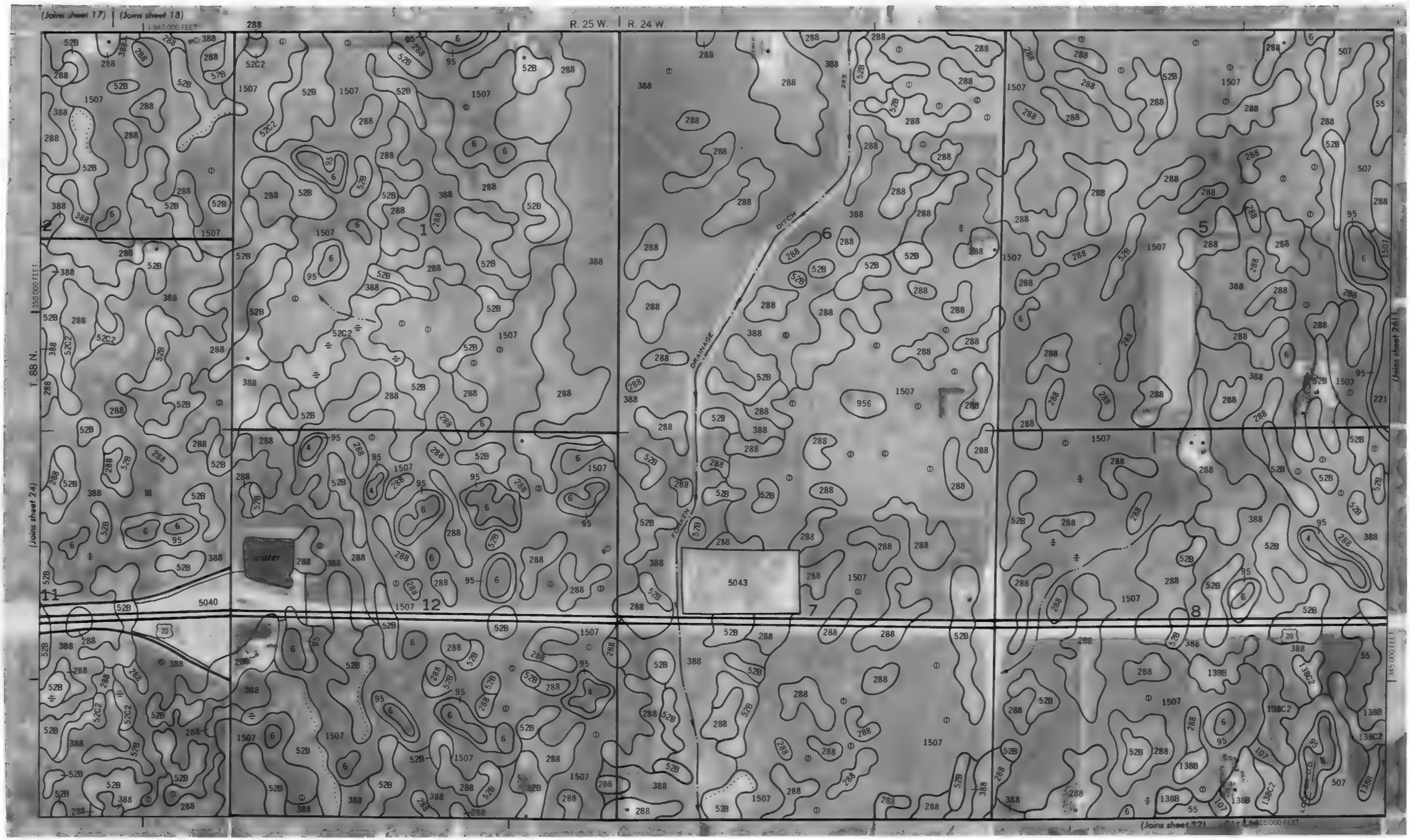

25

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

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N

R. 24 W. | R. 23 W.

(Joins sheet 19) (Joins sheet 20)

1 980 000 FEET

Skunk River

T. 88 N.

345 000 FEET

(Joins sheet 26)

DITCH

DRAINAGE

TUTTLE

1990

(Joins sheet 28)

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

28

N

(Joins 20) (Joins sheet 21)

R. 23 W. HARDIN COUNTY

2 010 000 FEET

1 Mile 5 000 Feet 0

Scale 1:15 840

¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

(Joins sheet 35)

T. 88 N. 1 500 000 FEET

HARDIN COUNTY

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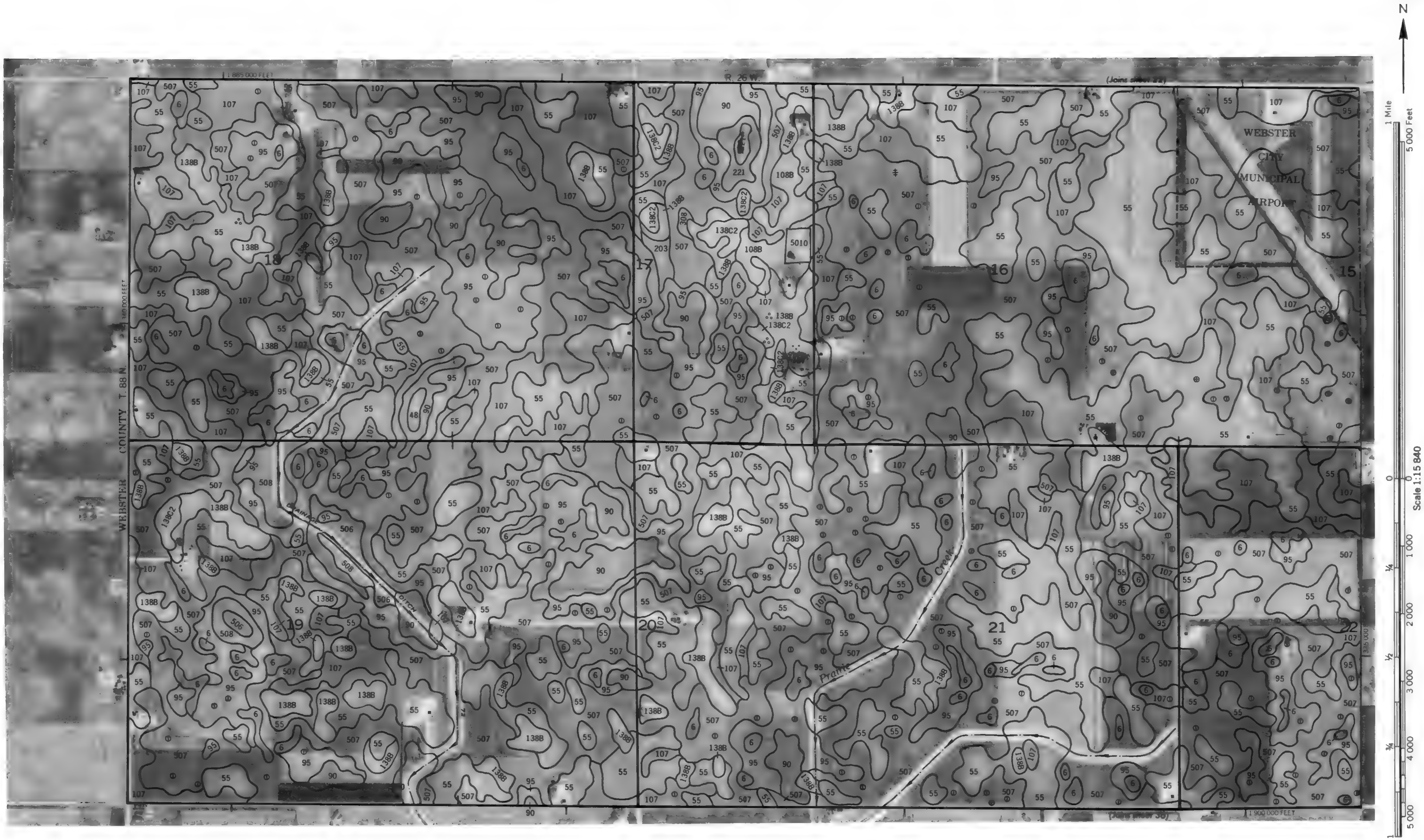

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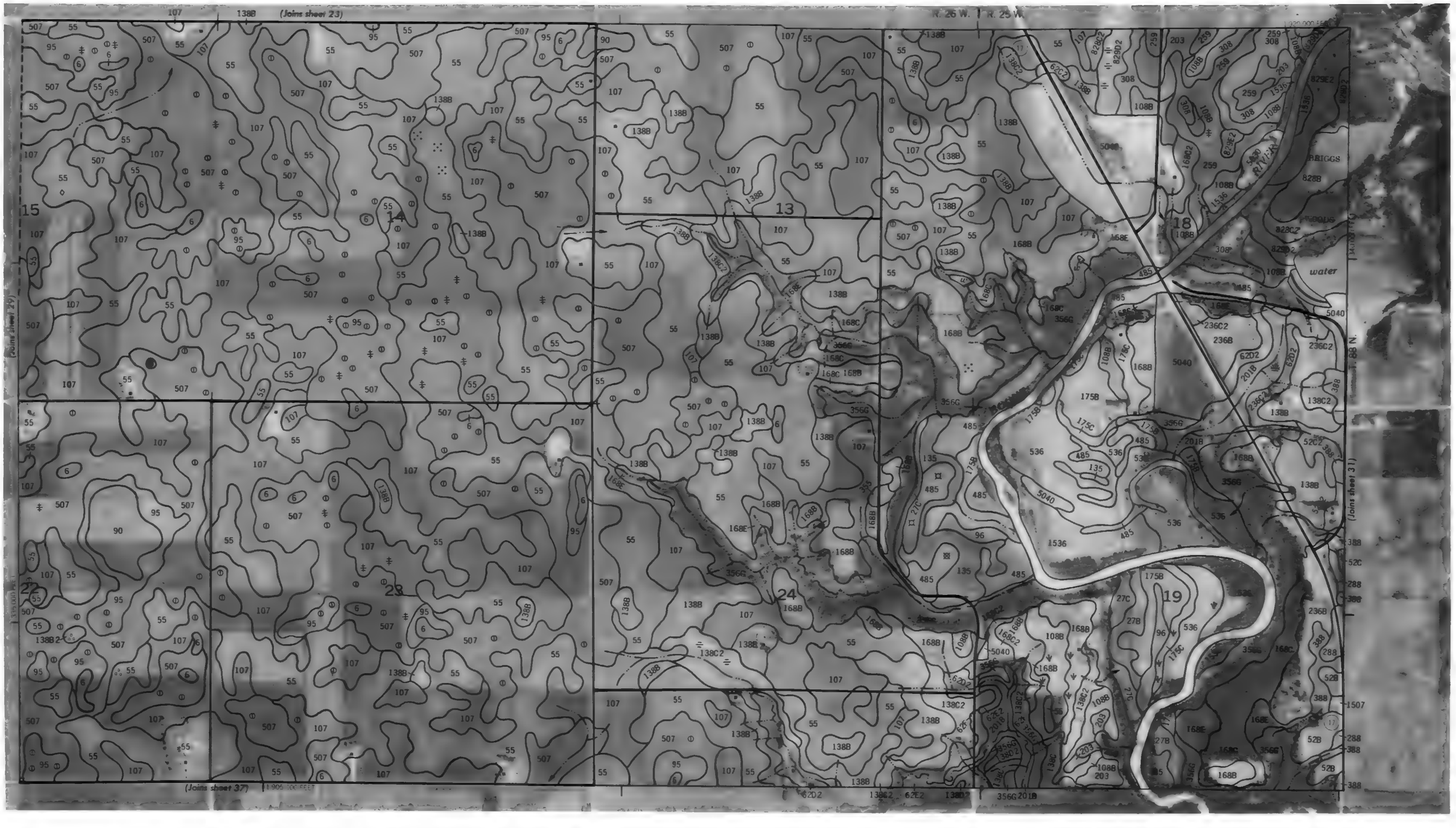
30

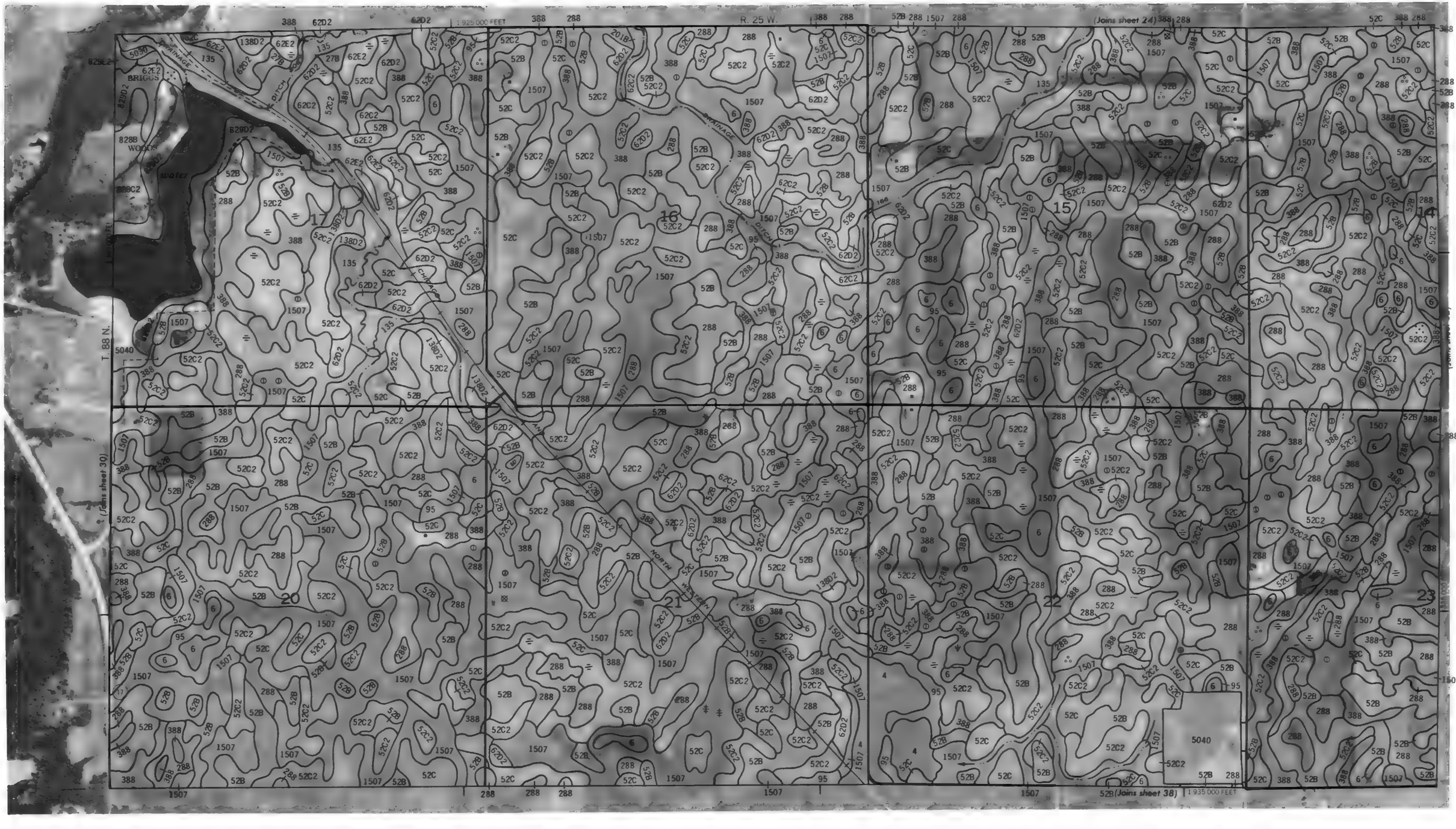
N

1 Mile

5 000 Feet

Scale 1:15 840





31

N

1 Mile

5 000 Feet

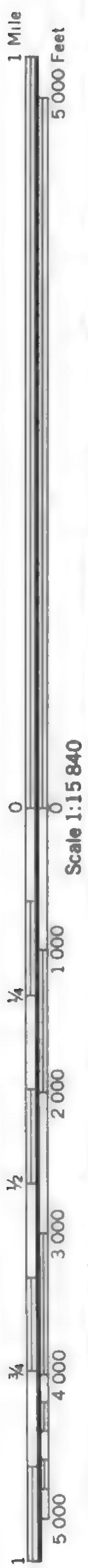
Scale 1:15 840

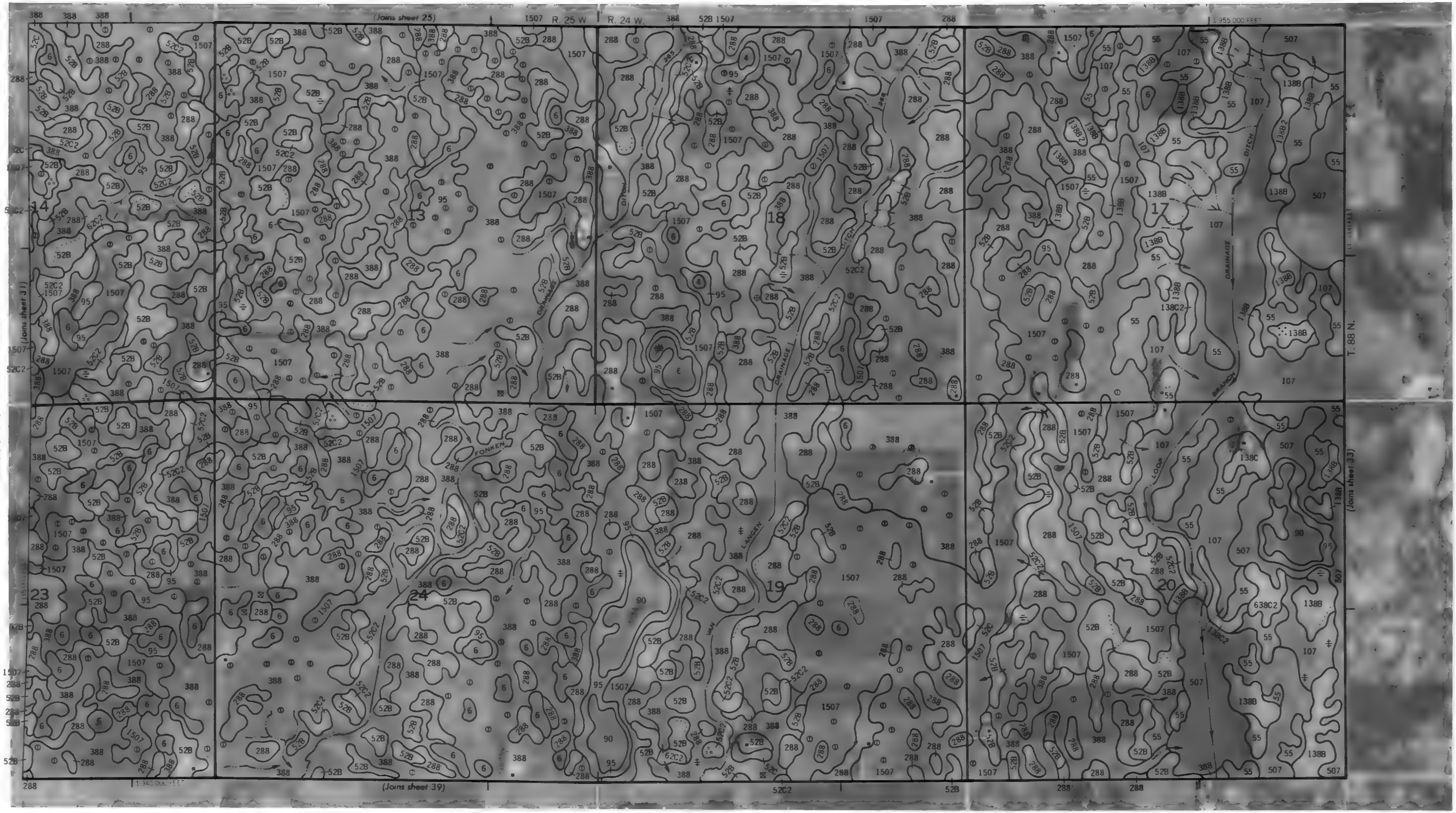
0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

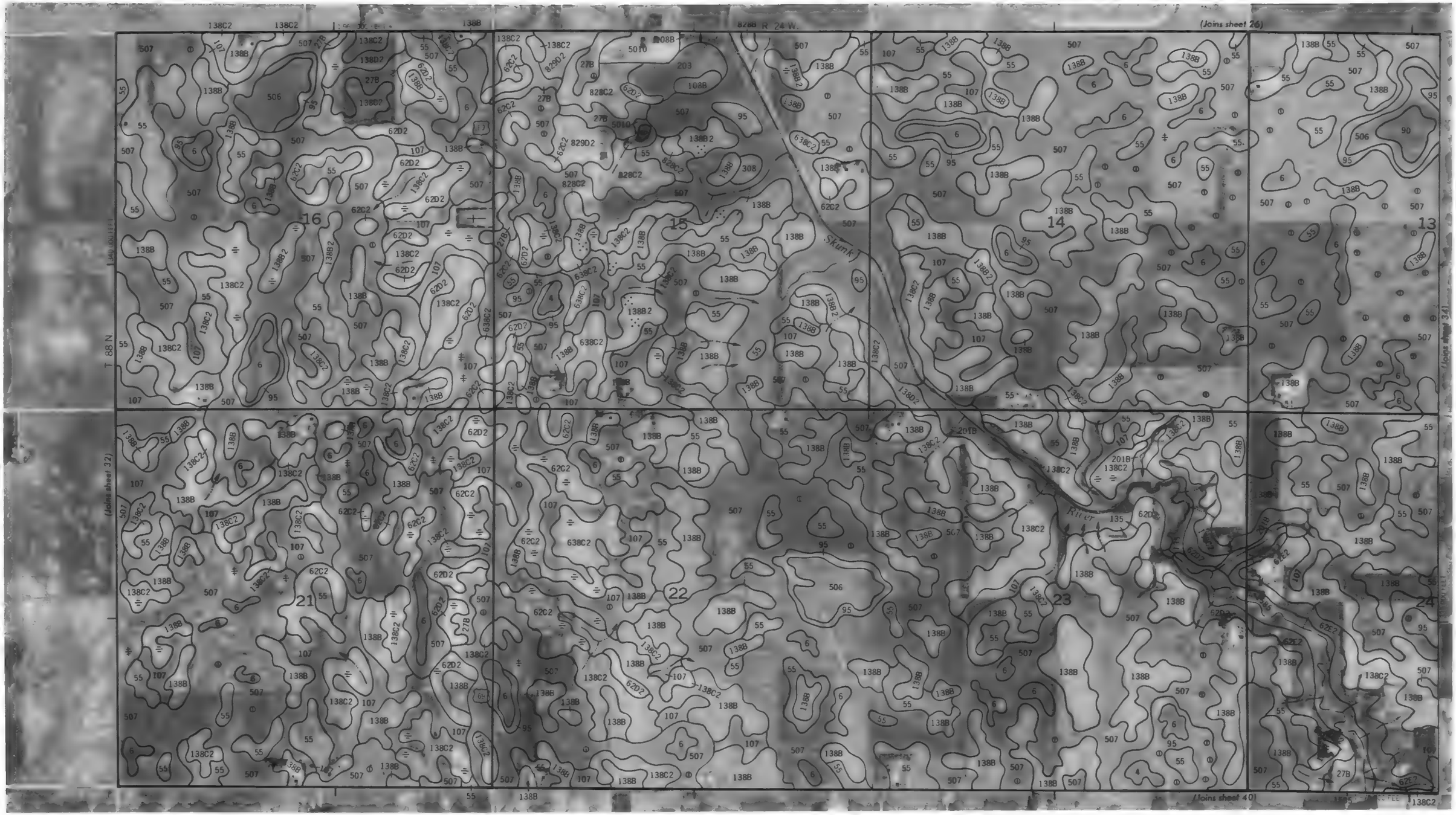
32

N





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



33

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

34

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 24 W. R. 23 W.

(Joins sheet 27)

(Joins sheet 35)

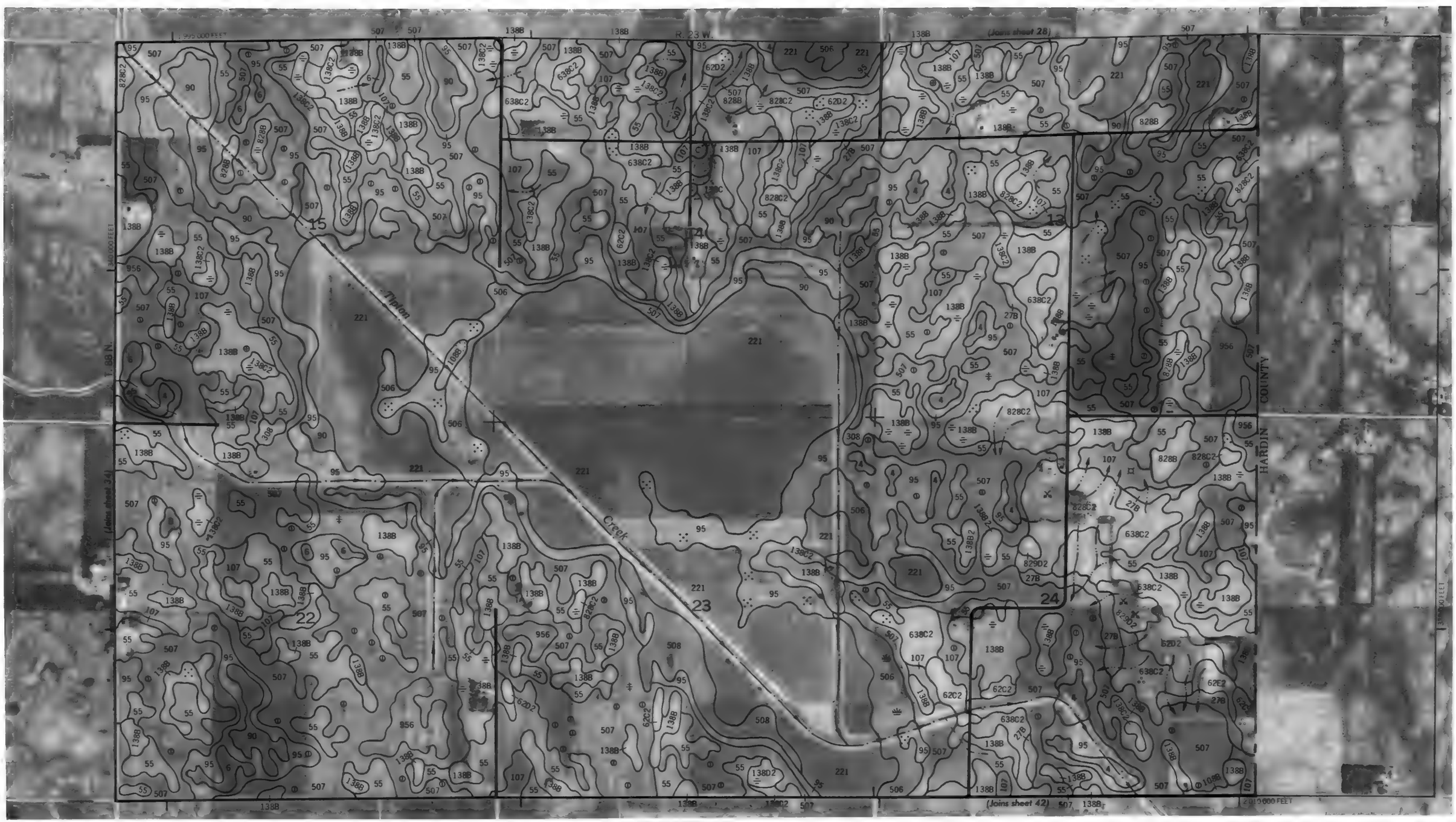
(Joins sheet 7)

T. 88 N.

13 18 17 16 19 20 21 24

5040 2018 1585

138B 138C2 62E2 107 507 55 6 95 90 956 82B2



35

N

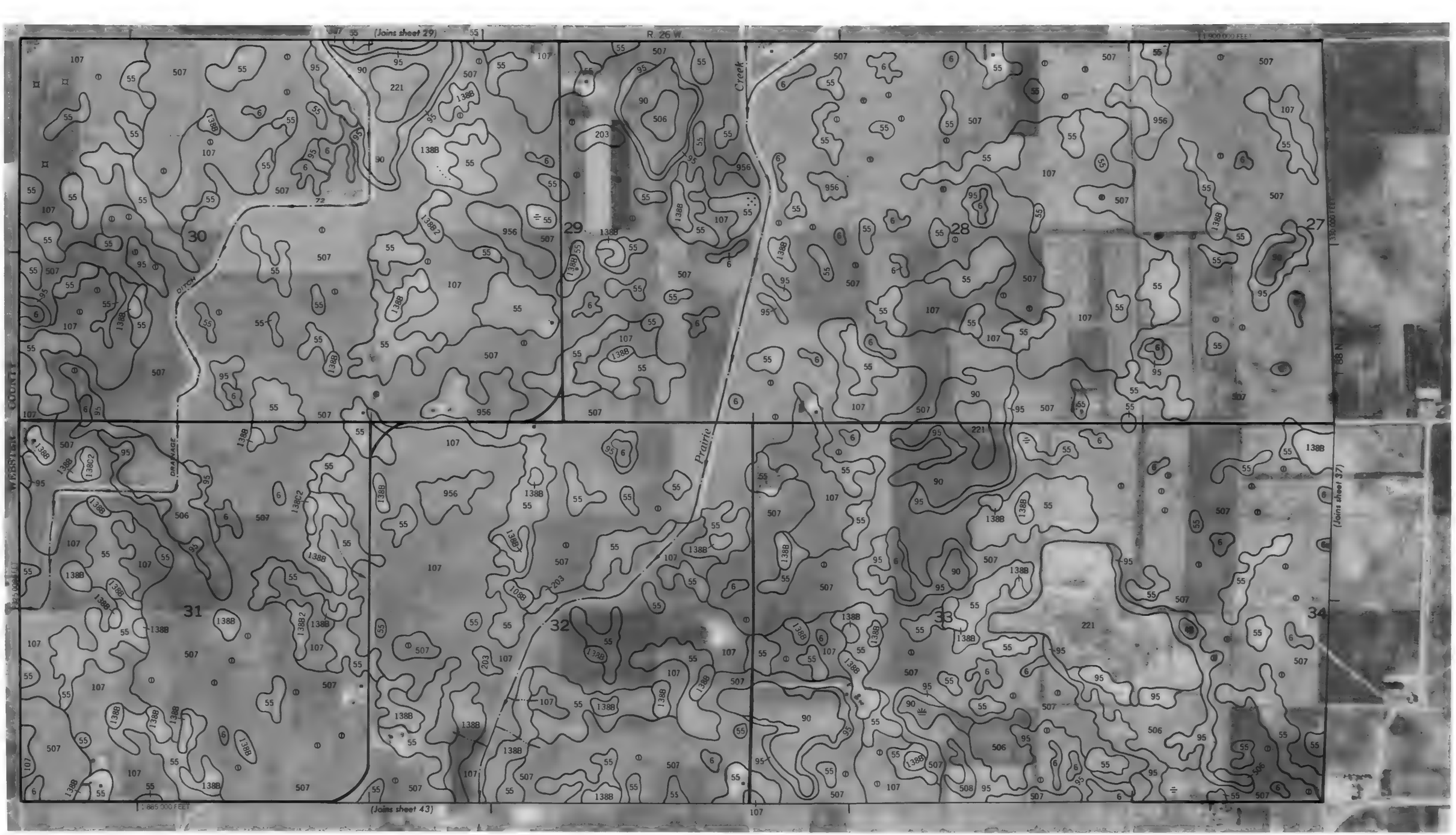
1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000



N

1 Mile

5 000 Feet

Scale 1:15 840

1 905 000 FEET

1 920 000 FEET

T. 88 N.

(Joins sheet 36)

(Joins sheet 44)

38

N

1 Mile

5 000 Feet

Scale 1:15 840

R 25 W.

1 935 000 FEET

310 000 FEET

T. 88 N.

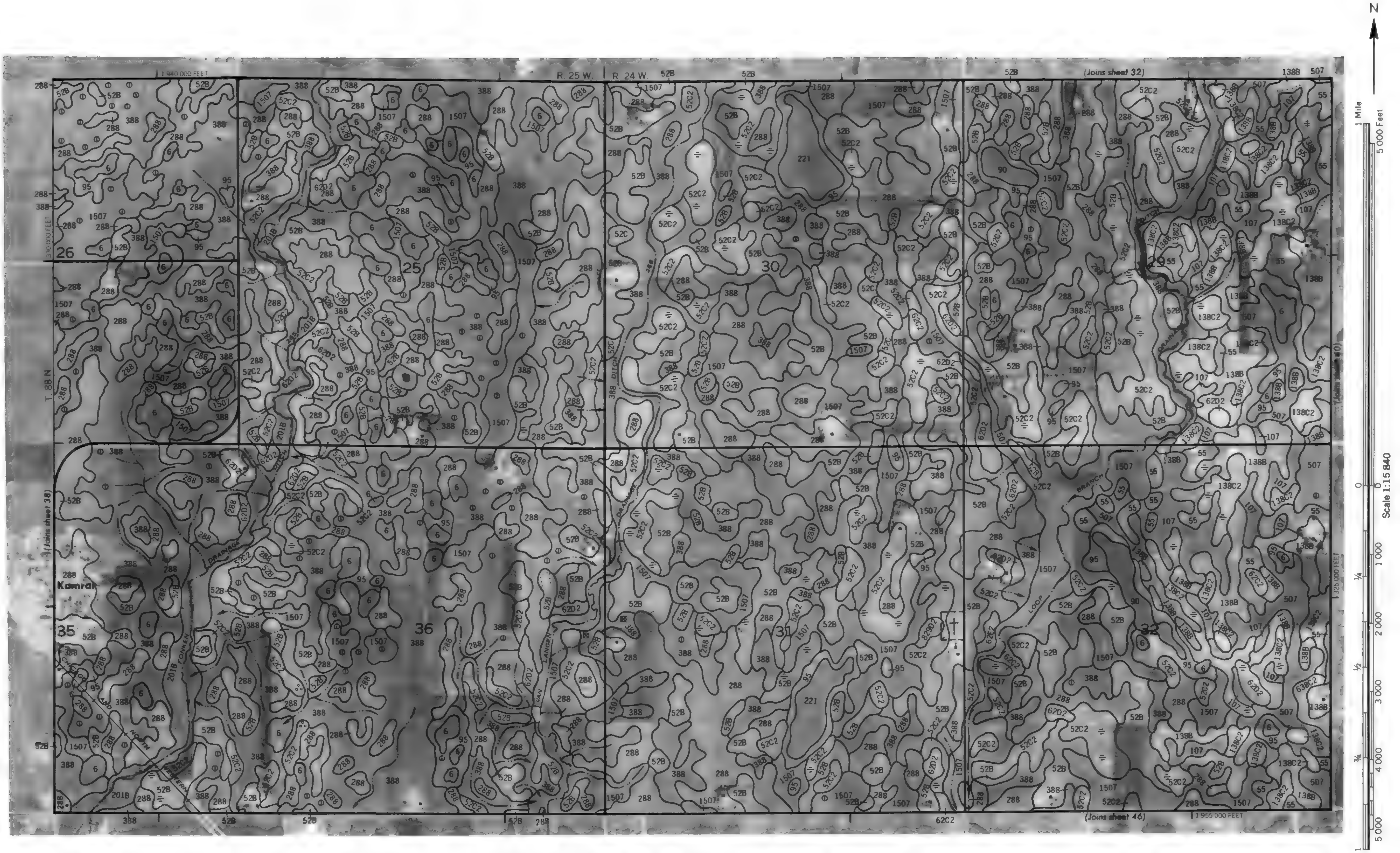
(Joins sheet 37)

(Joins sheet 45)

(Joins sheet 39)

Ramon

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, IOWA — SHEET NUMBER 40

40

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 33)

R. 24 W.

(Joins sheet 39)

(Joins sheet 47)

(Joins sheet 41)

T. 88 N.

Skunk River

DRAINAGE DITCH

PETTINGER

1 960 000 FEET

27 000 FEET

N

R. 24 W. | R. 23 W.

1 980 000 FEET

(Joins sheet 34)

T. 88 N.

(Joins sheet 40)

(Joins sheet 42)

1 990 000 FEET (Joins sheet 48)

335 000 FEET

Skunk River

New York Branch

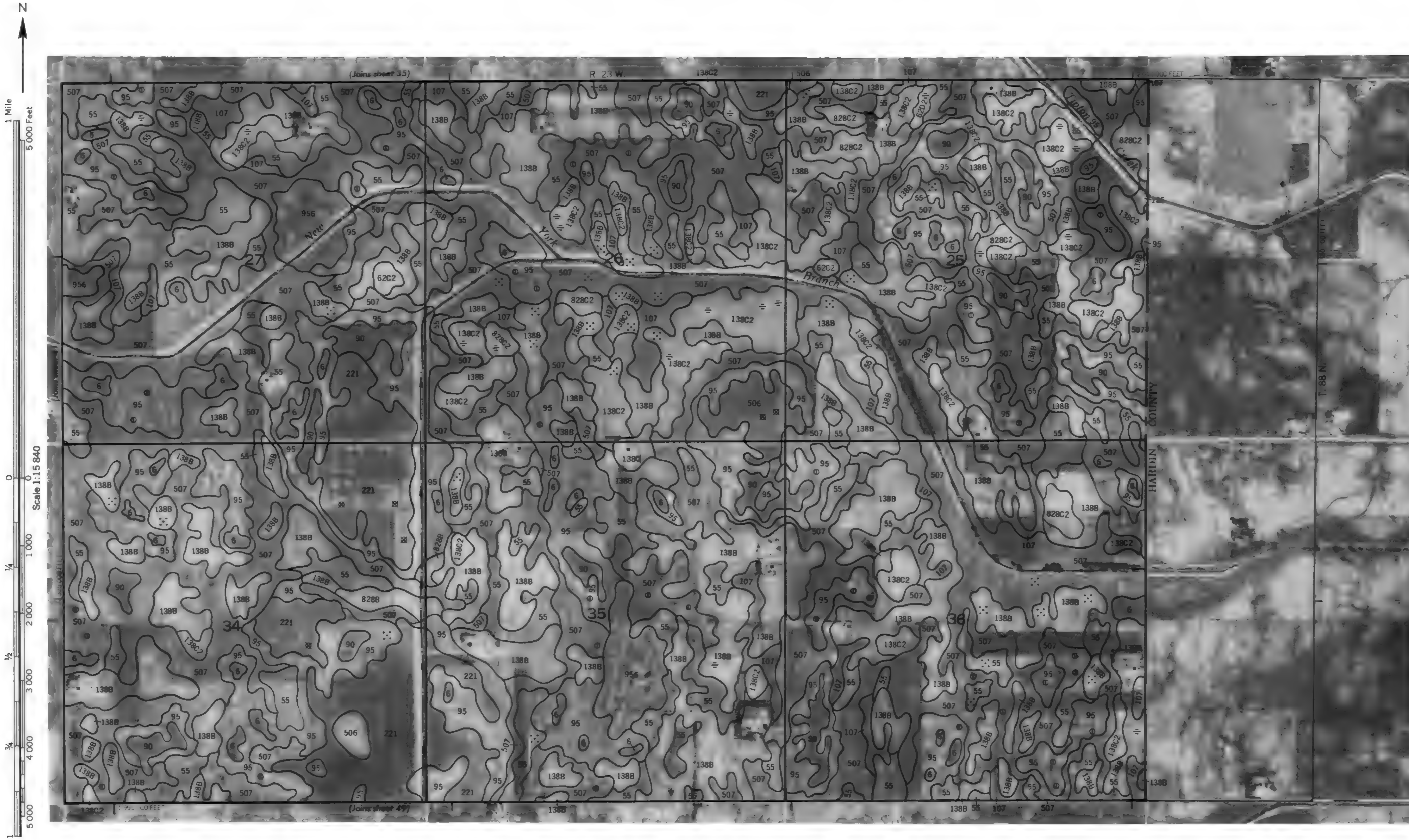
25 30 29 28 36 31 32 33 35

1 Mile

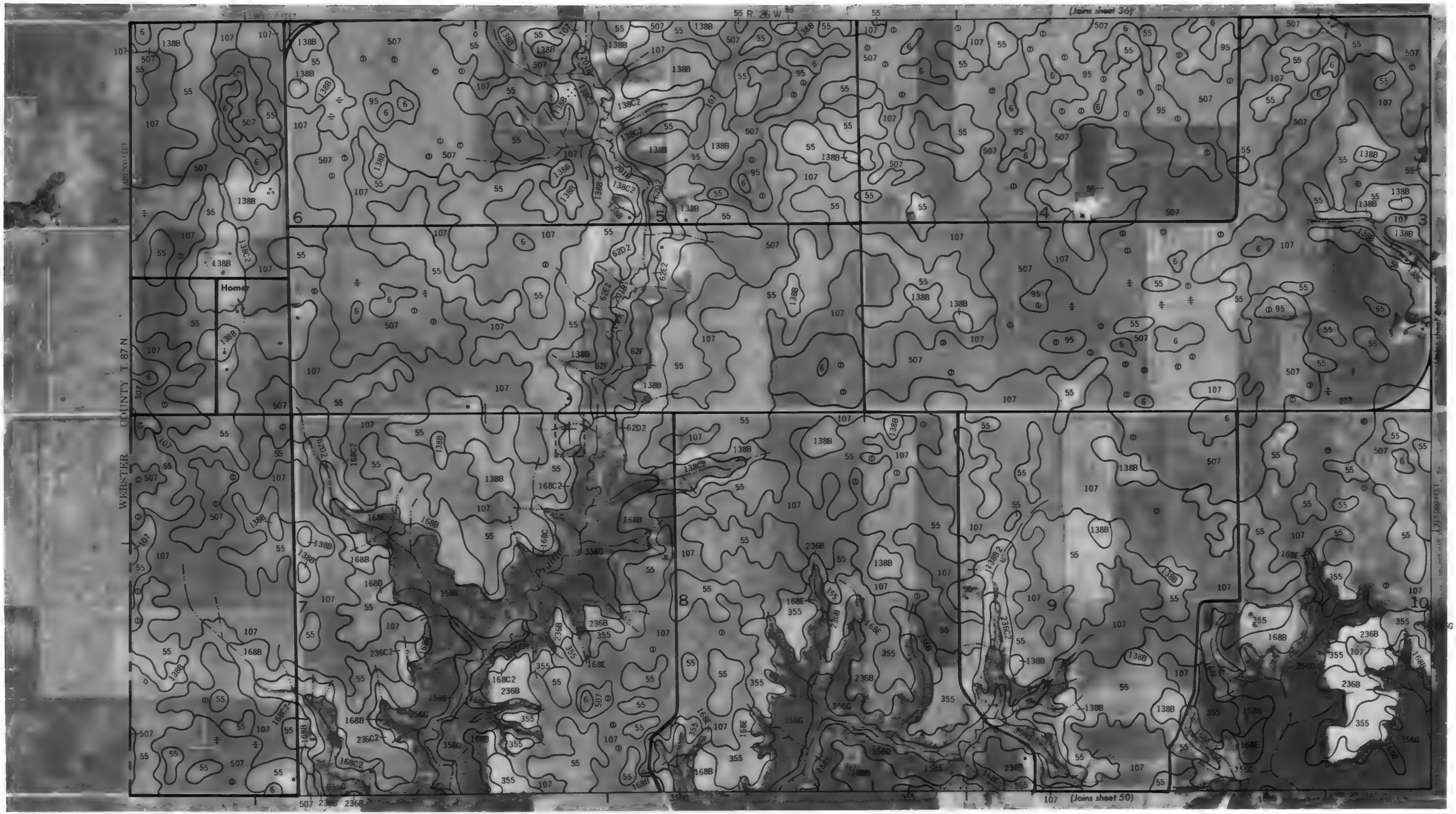
5 000 Feet

Scale 1:15 840

HAMILTON COUNTY, IOWA — SHEET NUMBER 42



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



43

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(44)

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 26 W. | R. 25 W.

T. 87 N.

(Joins sheet 37)

(Joins sheet 45)

(Joins sheet 51)

45

N

R. 25 W

T. 87 N

1 925 000 FEET

370 000 FEET

935 000 FEET

(Joins sheet 38)

(Joins sheet 44)

(Joins sheet 46)

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

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Coordinate grid ticks and land division corners, if shown, are approximately published

46

N

R. 25 W. | R. 24 W.

T. 87 N.

(Joins sheet 39)

(Joins sheet 53)

(Joins sheet 47)

1 955 000 FEET

1 940 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

FONHEN DITCH

CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY

VAN LANGEN DRAINAGE

DRAINAGE DITCH

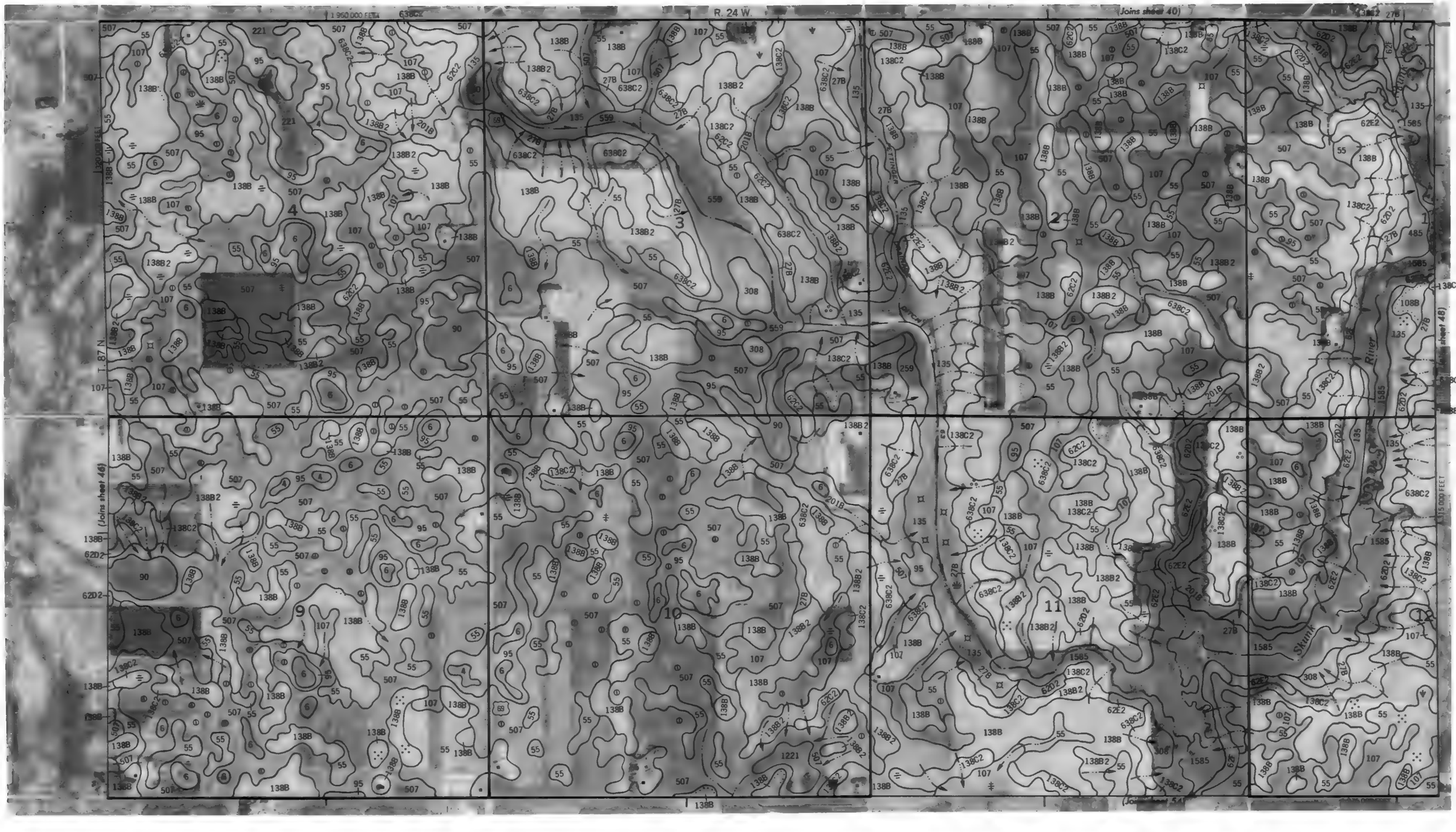
NORTH WATER LOOP

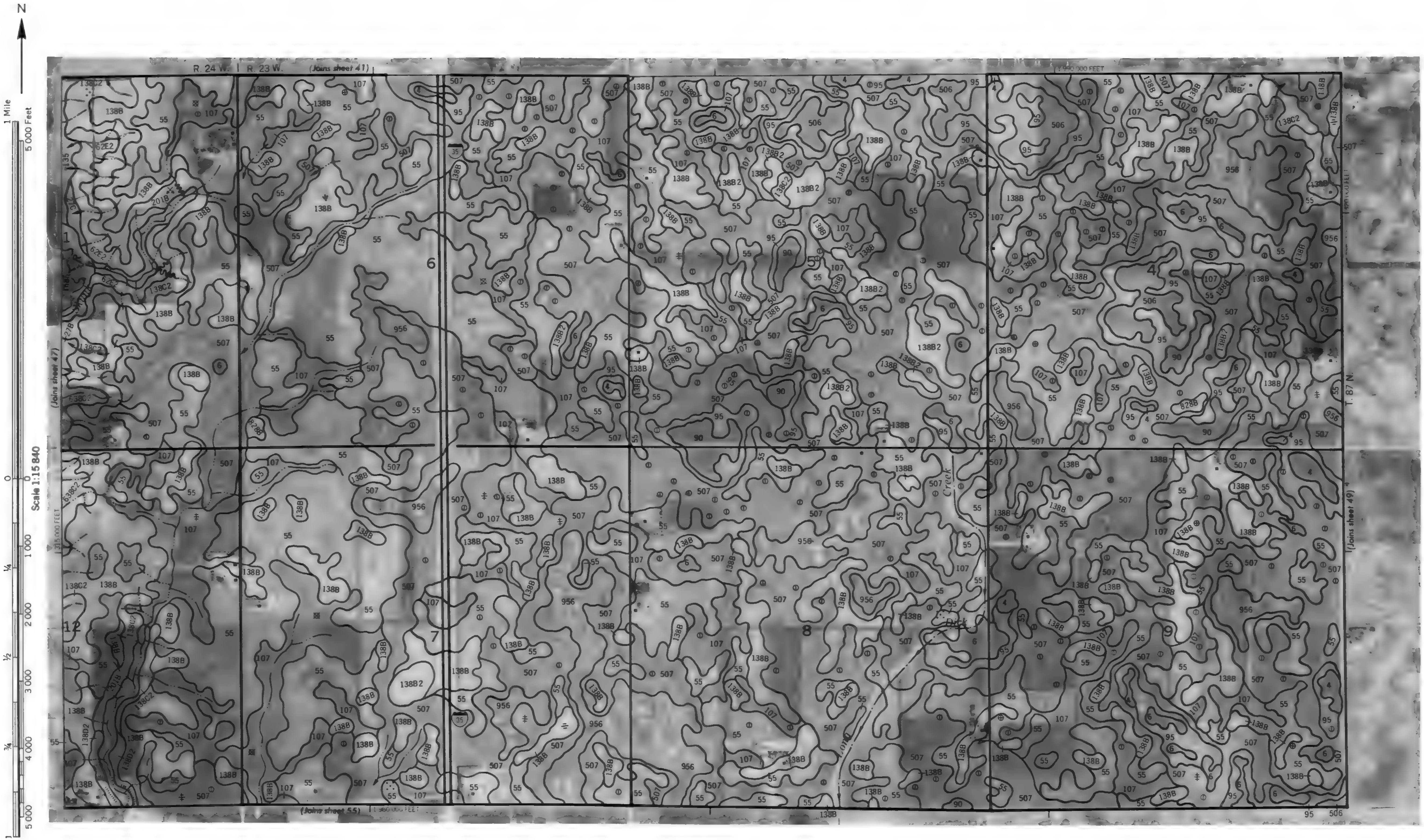
BRANCH

GROVE

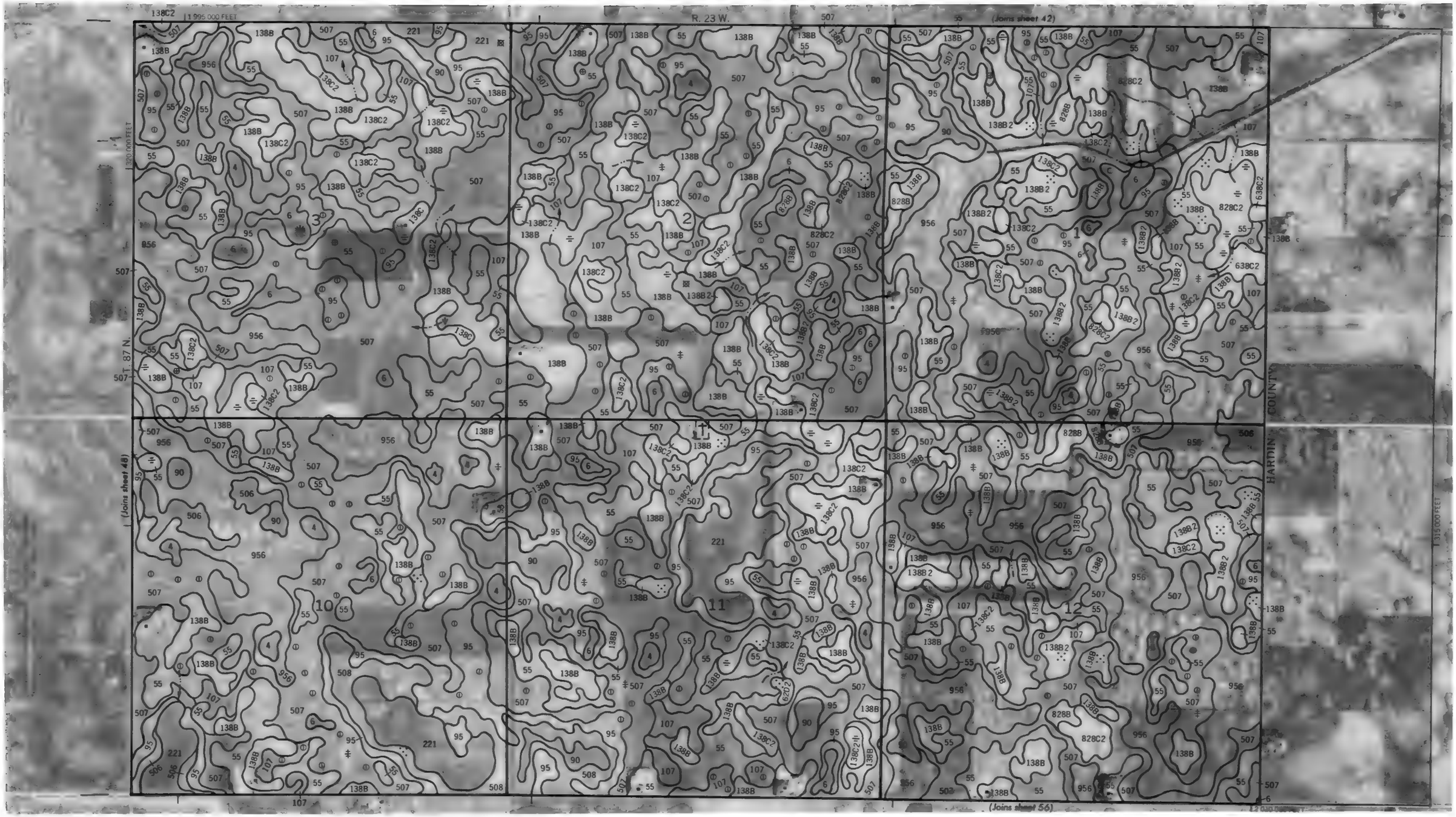
DRAINAGE DITCH

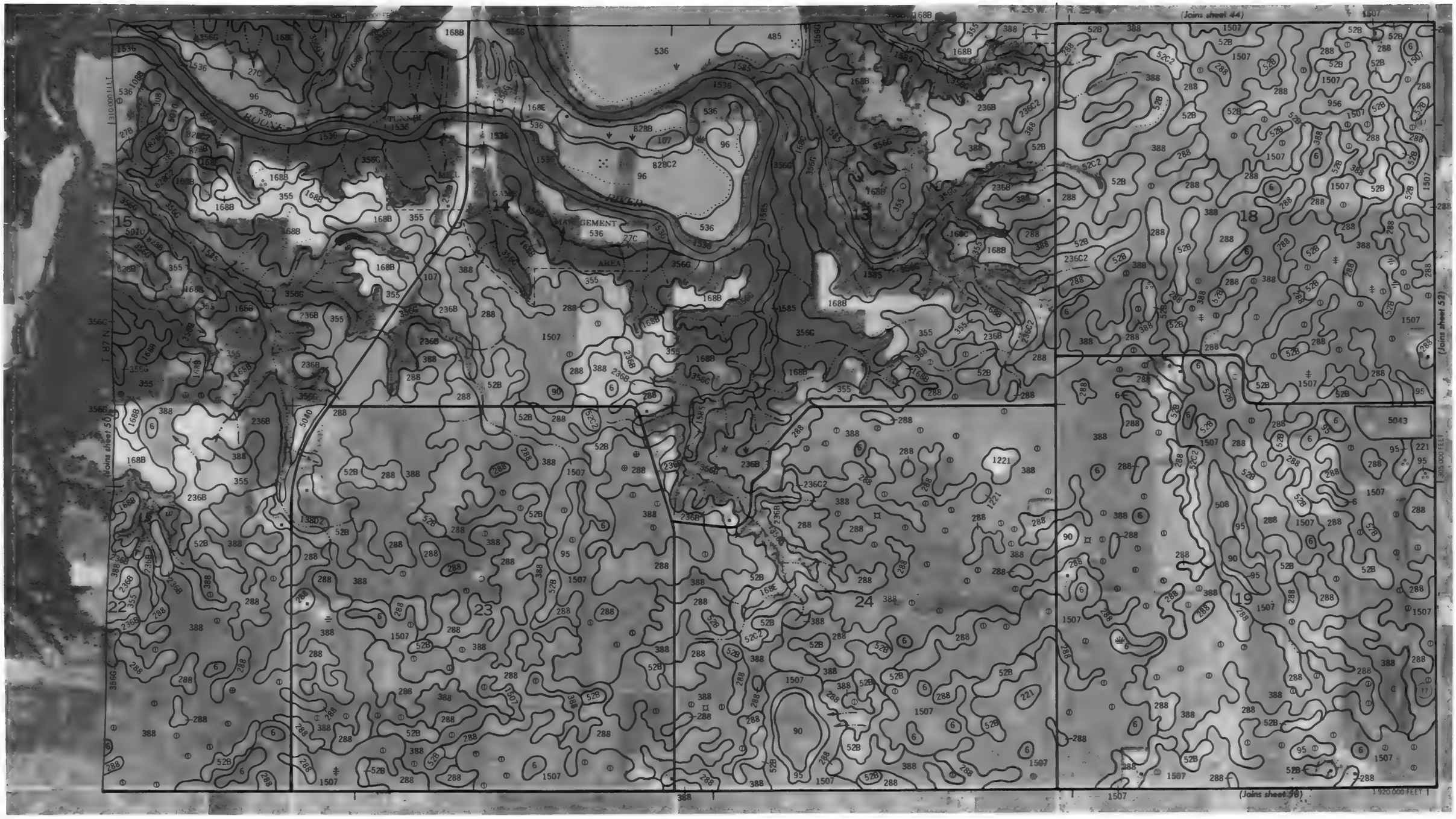
DRAINAGE DITCH





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.





51

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

52

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

(Joins sheet 45) 95

R 25 W.

(Joins sheet 51)

(Joins sheet 53)

(Joins sheet 59)

300 FEET

T. 87 N.

17 16 15 14

20 21 22 23

53

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 1/4 1 000 1/2 2 000 3/4 3 000 1 4 000 5 000

HAMILTON COUNTY, IOWA — SHEET NUMBER 54

54

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 47)

(Joins sheet 53)

(Joins sheet 55)

(Joins sheet 61)

R. 24 W.

T. 87 N.

16

15

14

21

22

23

24

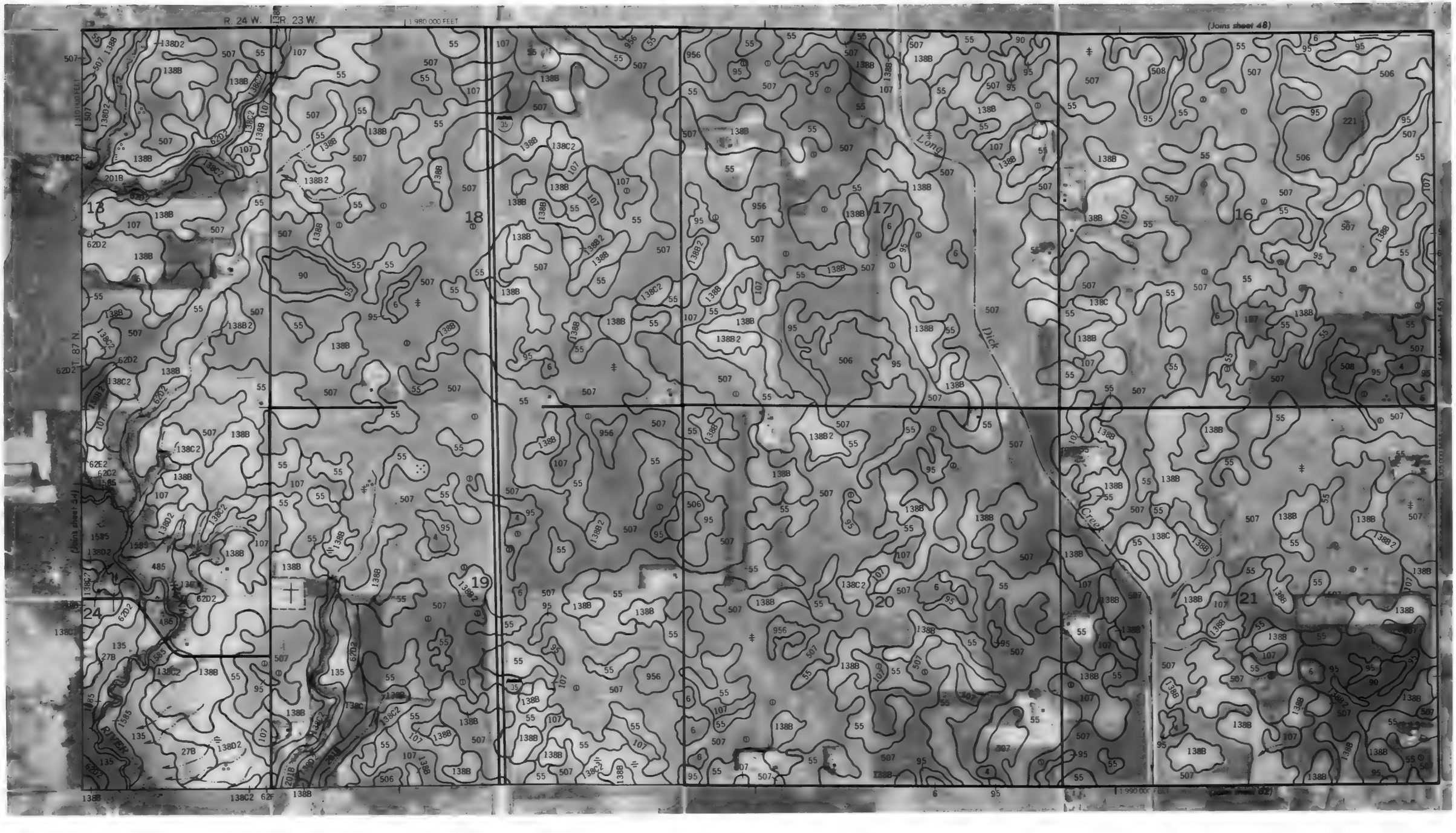
Skunk River

Skunk River

MUD CREEK

BRANCH

DITCH



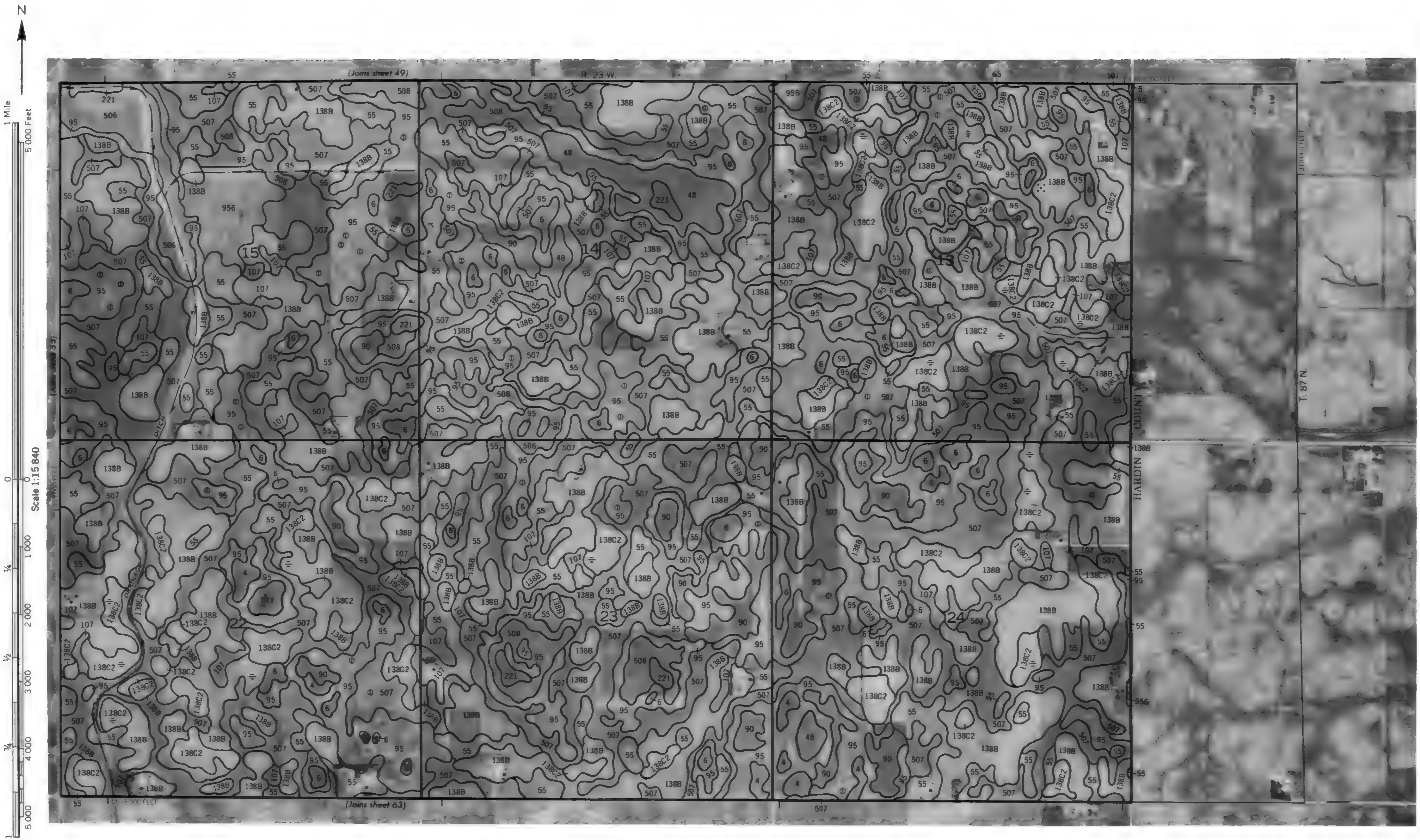
55

N

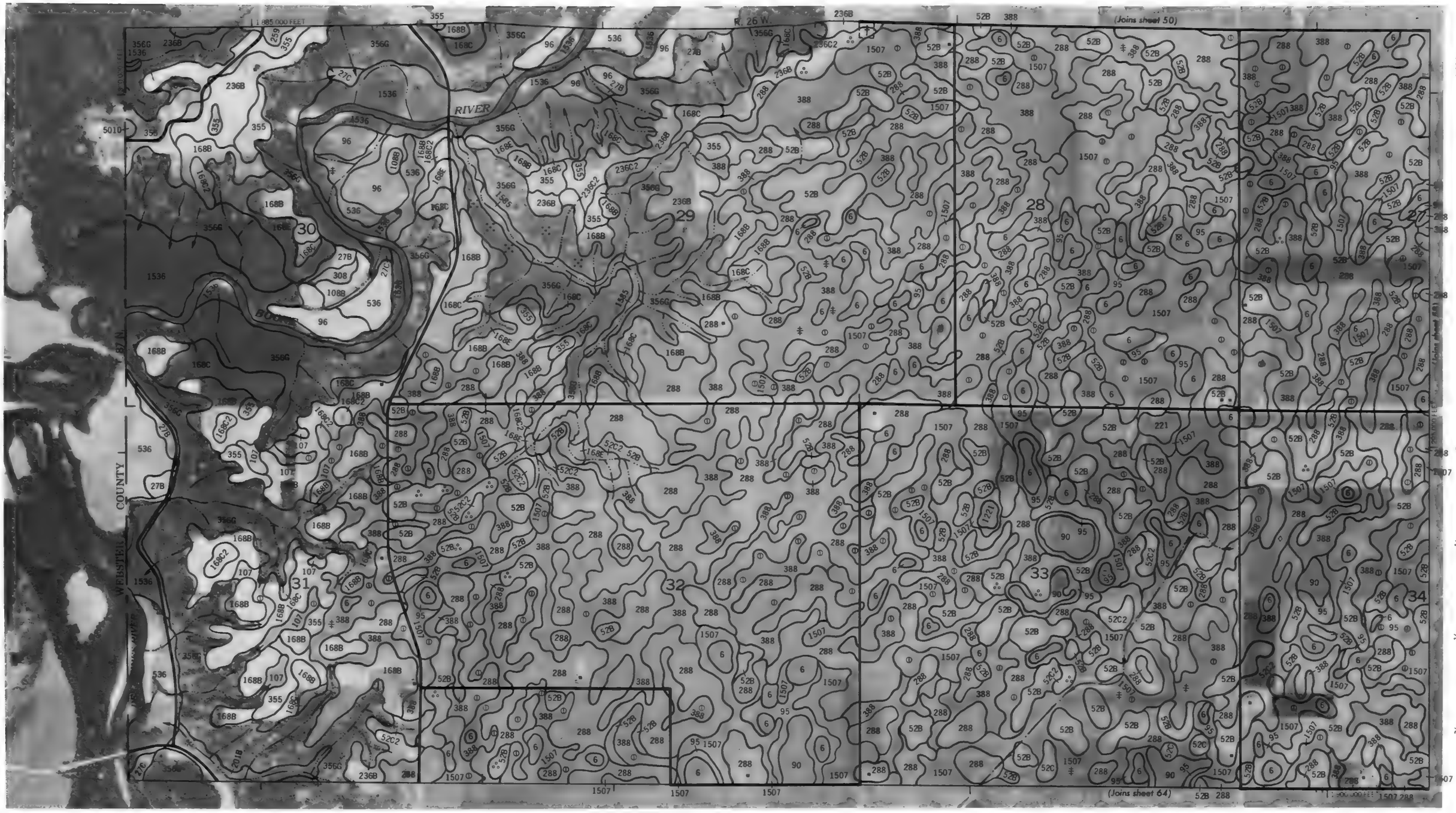
1 Mile

5 000 Feet

Scale 1:15 840



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



58

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 51)

(Joins sheet 57)

(Joins sheet 65)

(Joins sheet 59)

1 905 000 FEET

R. 26 W.

R. 25 W.

T. 89 N.

Creek

Crooked Creek

59

N

R. 25 W.

T. 87 N.

1 925 000 FEET

300 000 FEET

(Joins sheet 52)

(Joins sheet 58)

(Joins sheet 66)

1 935 000 FEET

RATHO BRANCH DRAINAGE DITCH

CHICAGO AND NORTH WESTERN

1 Mile

5 000 Feet

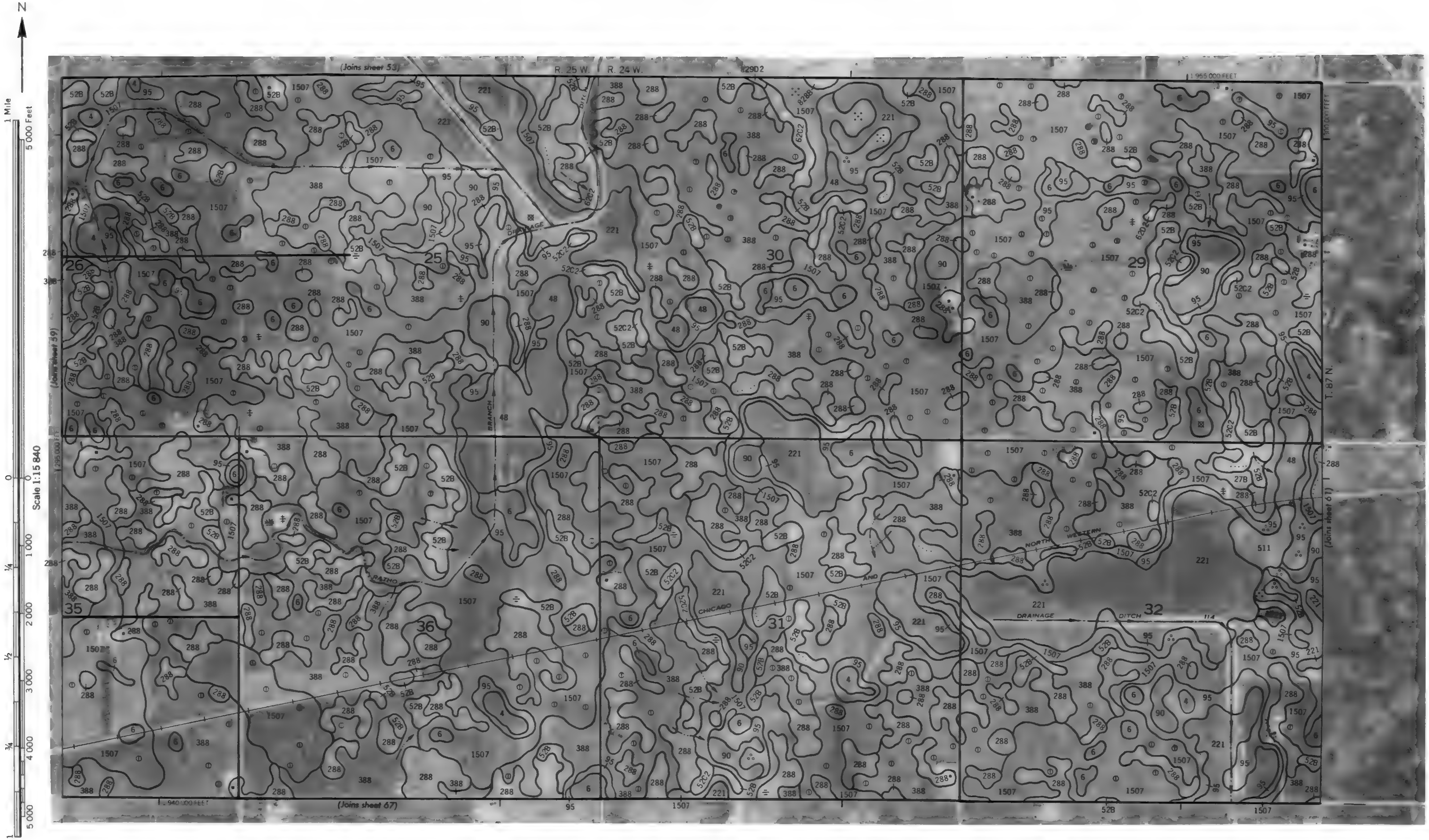
Scale 1:15 840

0 ¼ ½ ¾ 1

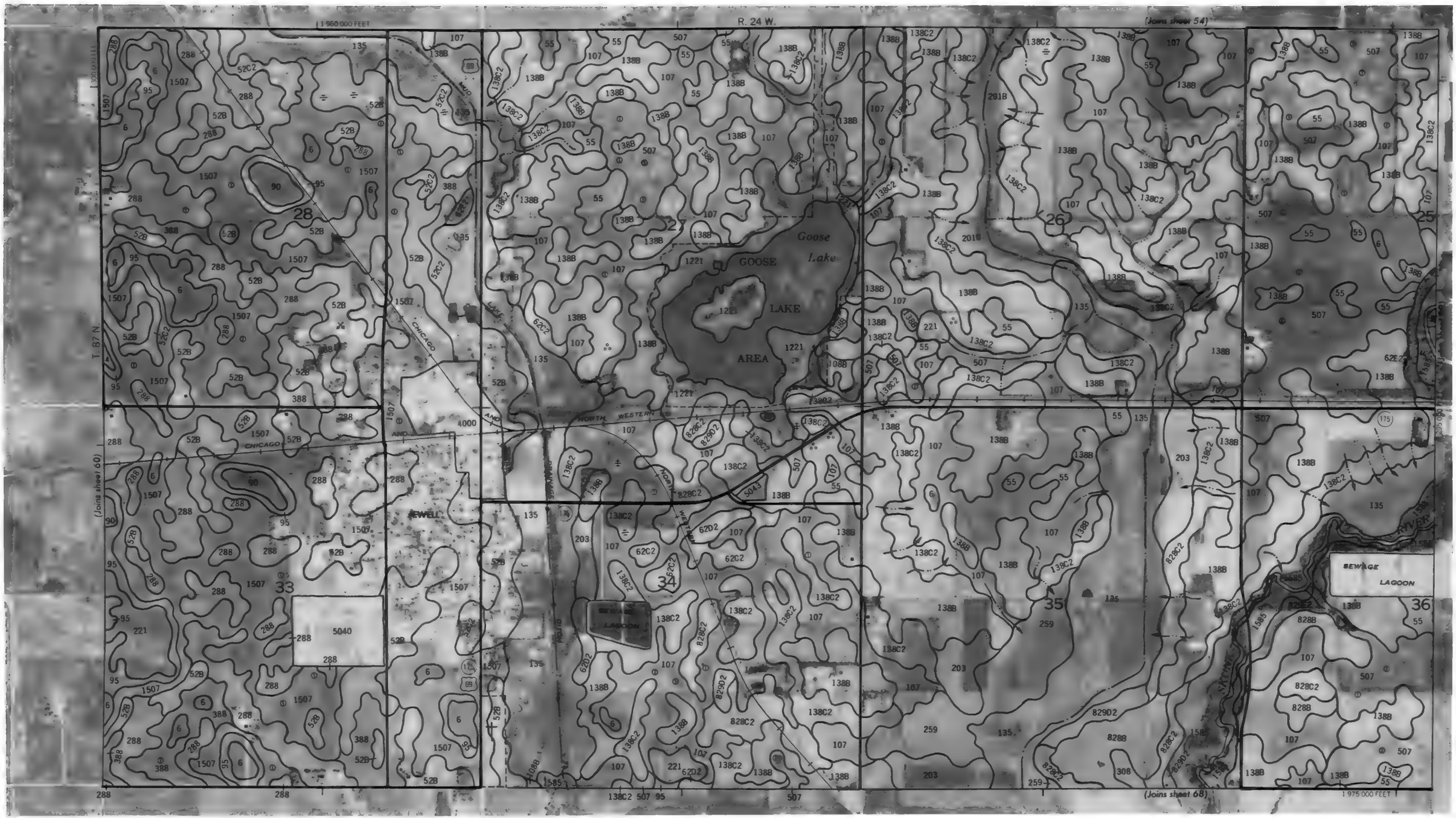
1 000 2 000 3 000 4 000 5 000

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

HAMILTON COUNTY, IOWA — SHEET NUMBER 60



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



62

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 24 W. | R.

(Joins sheet 53)

(Joins sheet 69)

(Joins sheet 63)

Ellsworth

CHICAGO AND NORTH WESTERN

Skunk River

Fluor Creek

25 30 29 28 36 31 32 33

5040

63

N

1 Mile 5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

1 995 000 FEET

300 000 FEET

R. 23 W.

(Joins sheet 56)

T. 87 N.

(Joins sheet 62)

(Joins sheet 70)

HARDIN COUNTY

CHICAGO NORTH WESTERN AND

ORANGE DITCH

64

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 57)

R. 26 W.

T. 86 N.

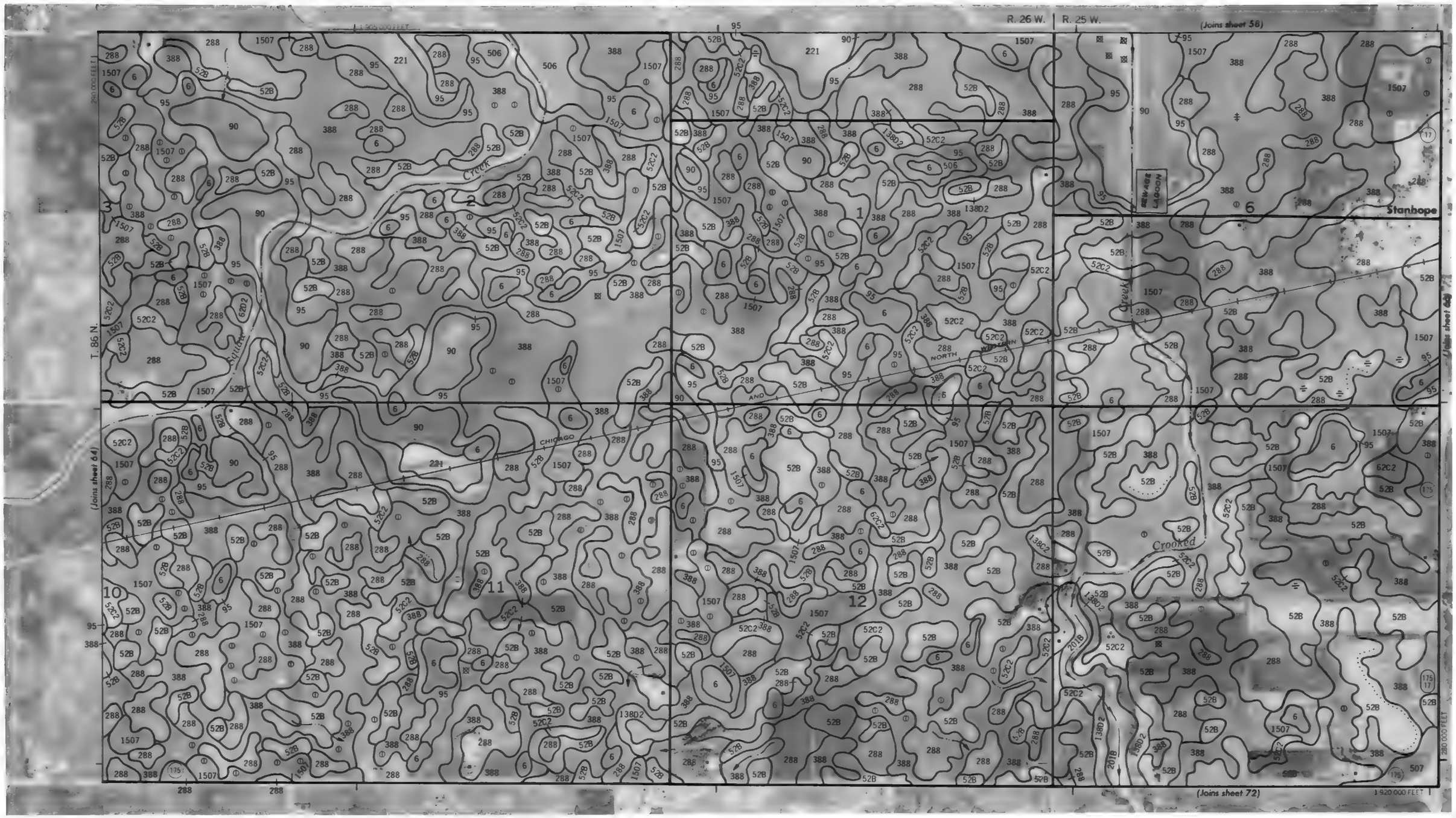
Square Creek

Stratford

CHICAGO, NORTH WESTERN AND

(Joins sheet 71)

(Joins sheet 65)



N

1 Mile

5 000 Feet

Scale 1:15 840

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and idea division corners, if shown, are approximately positioned

66

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

R. 25 W.

T. 86 N.

(Joins sheet 59)

(Joins sheet 67)

(Joins sheet 73)

(Joins sheet 65)

1 935 000 FEET

1 930 000 FEET

1 925 000 FEET

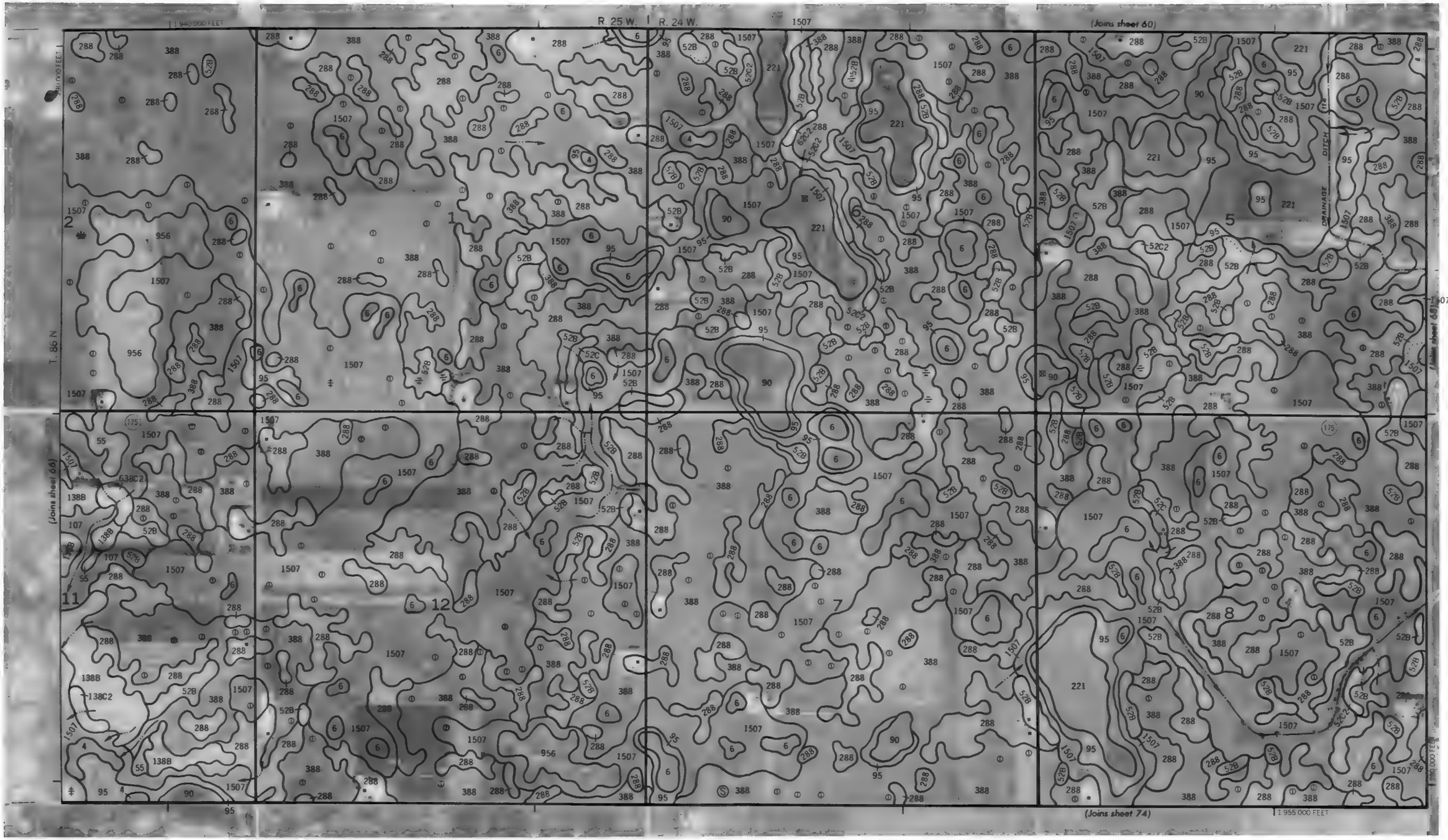
1 940 000 FEET

Grantham

CHICAGO AND NORTH WESTERN

water

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



68

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 67)

R. 24 W.

T. 86 N.

(Joins sheet 69)

LITTLE WALL LAKE AREA

Little Wall Lake

52C2 (Joins sheet 75)

CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD

SKUNK RIVER

DRAINAGE DITCH

LATERAL DITCH

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

R. 24 W. R. 23 W.

T. 86 N.

(Joins sheet 62)

(Joins sheet 68)

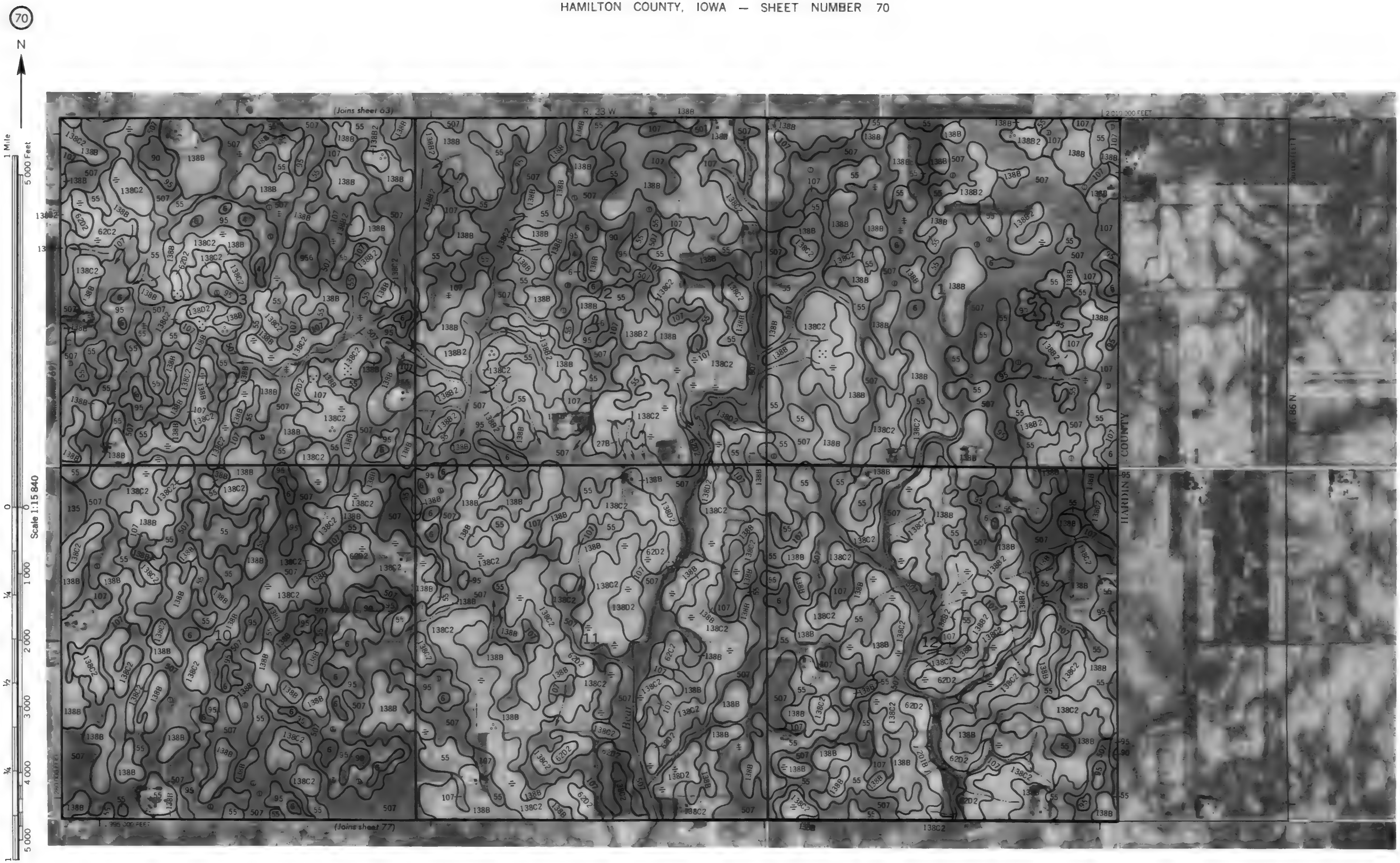
(Joins sheet 76)

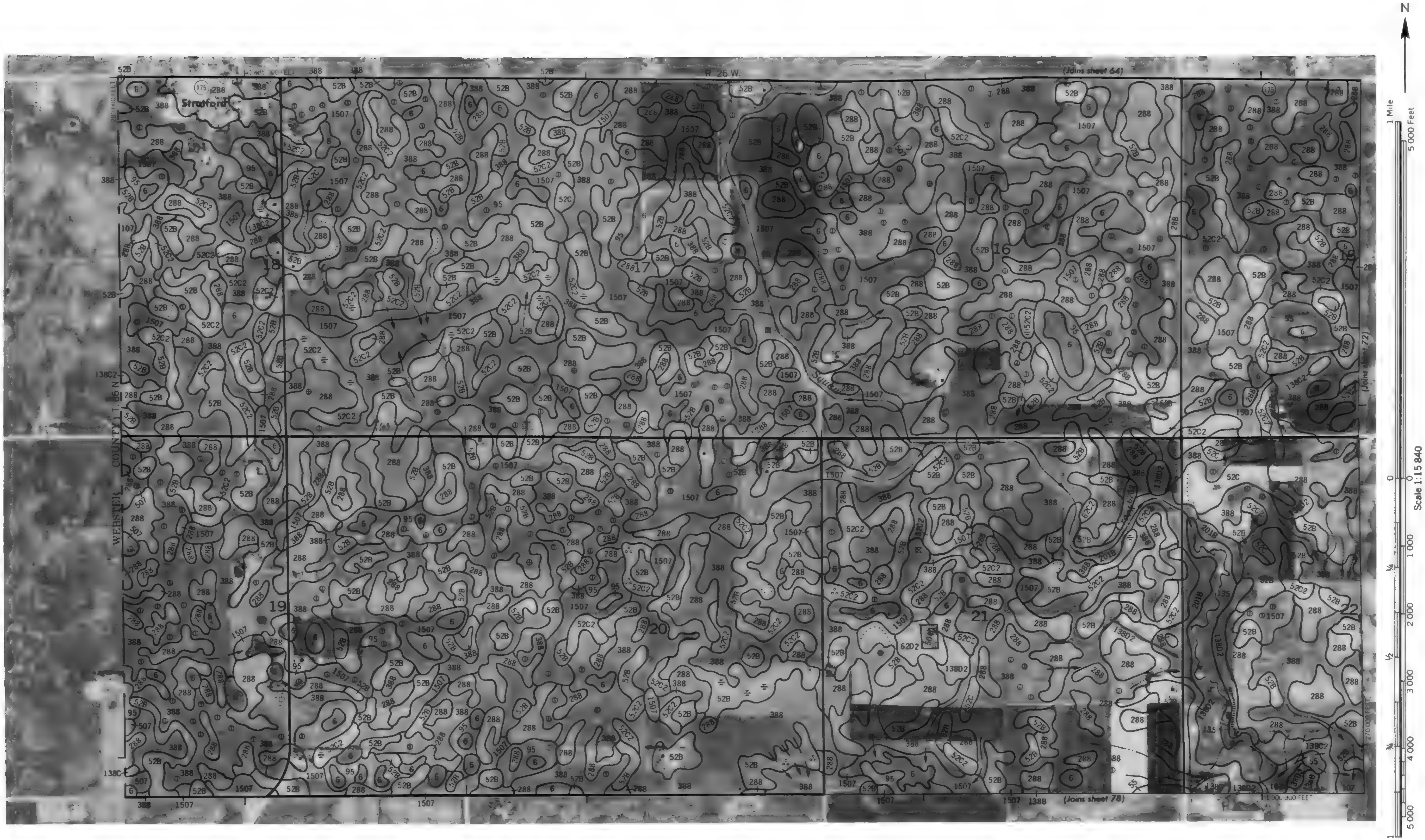
1 Mile

5 000 Feet

Scale 1:15 840

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


70
N
(Joins sheet 63)
R. 23 W
(Joins sheet 77)
HARDIN COUNTY
T. 86 N.
Scale 1:15 840
1 Mile
5 000 Feet


N
Stratford
R. 26 W.
(Joins sheet 64)
(Joins sheet 78)
WEBSTER COUNTY
T. 86 N.
1 Mile
5 000 Feet
Scale 1:15 840

72

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 65)

R. 26 W.

R. 25 W.

T. 86 N.

(Joins sheet 71)

(Joins sheet 73)

(Joins sheet 79)

Squaw Creek

Crooked Creek

N

1 Mile

5 000 Feet

Scale 1:15 840

74

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

5 000 0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 67)

R. 25 W. | R. 24 W.

1 955 000 FEET

270 000 FEET

(Joins sheet 75)

(Joins sheet 81)

Keigley Branch

75

N

1 Mile

5 000 Feet

Scale 1:15 840

0 1/4 1/2 3/4 1

0 1 000 2 000 3 000 4 000 5 000

76

N

1 Mile

5 000 Feet

Scale 1:15 840

R 24 W. R 23 W.

(Joins sheet 69)

(Joins sheet 83)

(Joins sheet 77)

T. 86 N.

Long

Dick

HEPSE GAME MANAGEMENT AREA

SKUNK R.

1 980 000 FEET

1 990 000 FEET

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77

N

1 Mile

5 000 Feet

Scale 1:15 840

78

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 71)

R 26 W.

T. 86 N.

(Joins sheet 79)

WEBSTER COUNTY

BOONE COUNTY

Creek

DRAINAGE DITCH

JOINT

CAIM

29

30

31

32

33

34

28

27

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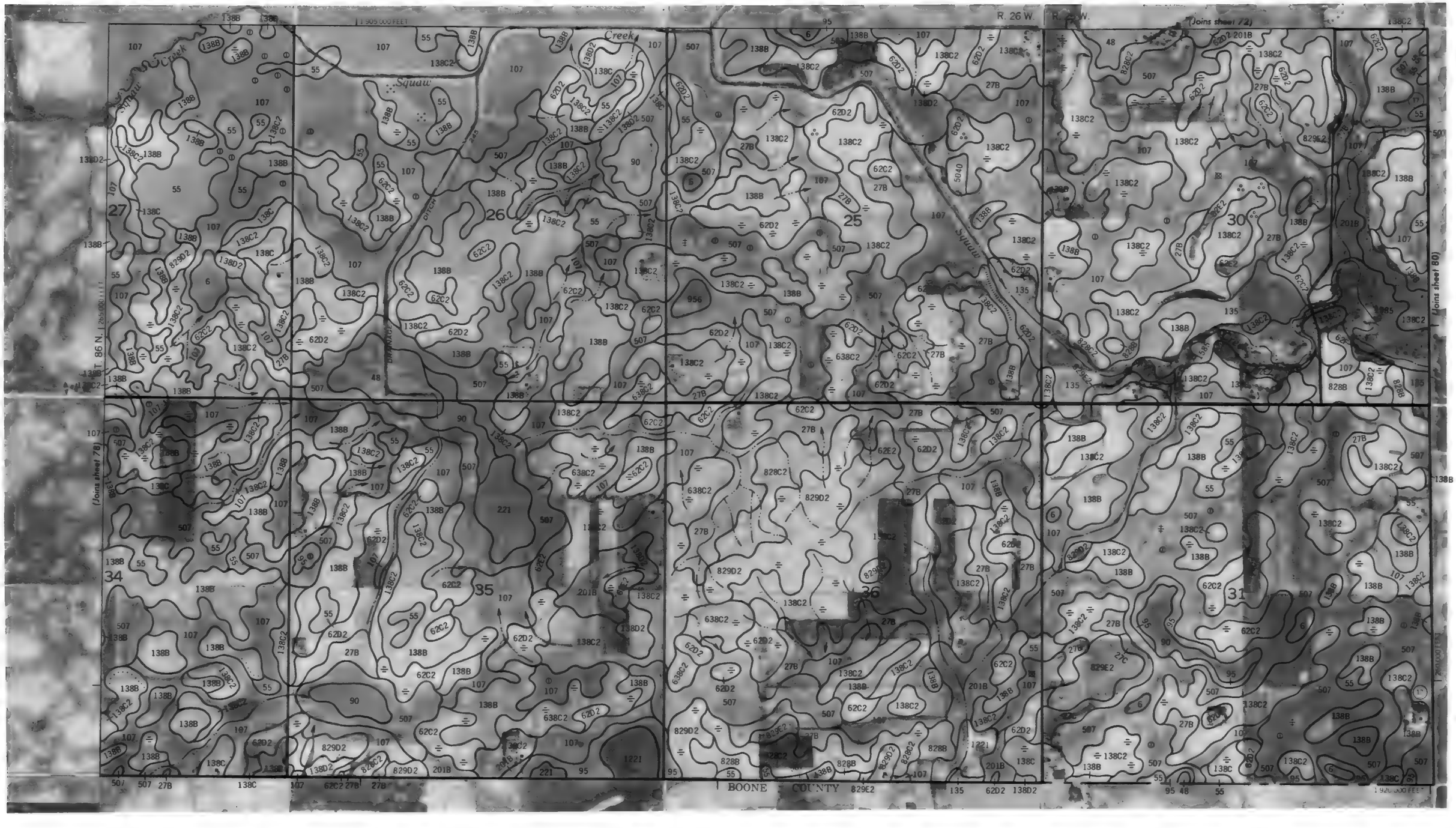
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



79

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

80

N

1 Mile

5 000 Feet

Scale 1:15 840

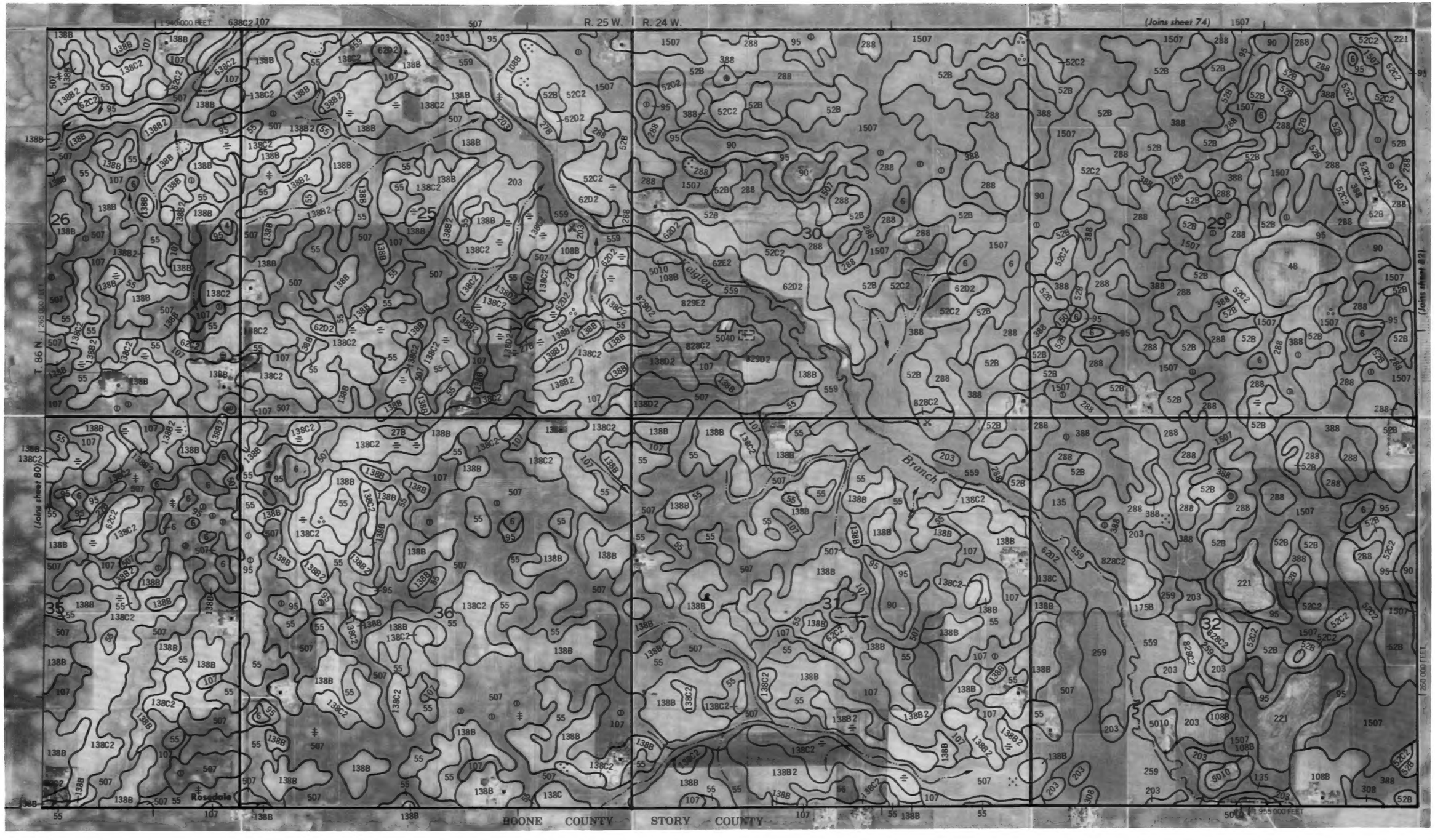
(Joins sheet 73)

R. 25 W.

(Joins sheet 81)

SCOTT DRAINAGE DITCH

BOONE COUNTY



81

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

82

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 75)

R. 24 W.

1 975 000 FEET

(Joins sheet 81)

1 960 000 FEET

T. 86 N.

(Joins sheet 83)

STORY COUNTY

Randall

Miller

Creek

CHICAGO

NORTHWESTERN

28

27

26

25

33

34

35

36

(Joins sheet 82)
(Joins sheet 76)
(Joins sheet 84)

R. 24 W. R. 23 W. 5040

1 980 000 FEET

T. 86 N. 1 265 000 FEET

STORY COUNTY

1 390 000 FEET

1 360 000 FEET

SKUNK RIVER

Vine Creek

83

N

1 Mile 5 000 Feet

Scale 1:15 840

84

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 23 W.

(Joins sheet 77)

(Joins sheet 83)

2 010 000 FEET

T. 86 N.

265 000 FEET

260 000 FEET

1 995 000 FEET

COUNTY

HARDIN

STORY COUNTY

Long Dick Creek

Beaver Creek

water